THE TOWNE SCIENTIFIC SCHOOL JOURNAL

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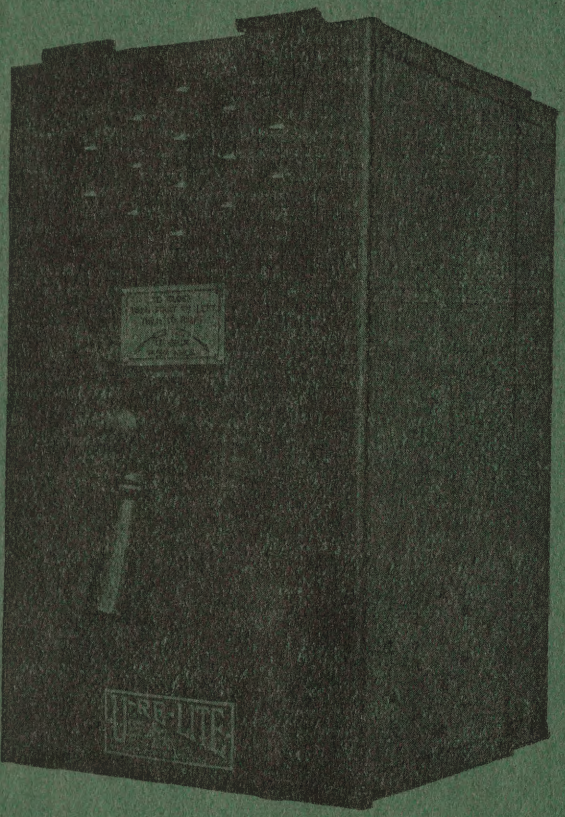
U-RE-LITE



THE U-RE-LITE is an appliance WHICH ELIMINATES THE DELAYS, ANNOYANCES AND CONTINUED EXPENSE INCIDENT UPON THE BLOWING OF FUSES. It is an I-T-E CIRCUIT BREAKER enclosed within a specially constructed steel case, from the front of which projects a convenient operating handle. THE INITIAL COST OF THE U-RE-LITE IS THE ONLY COST! It not only gives 100% protection to the motor or lighting circuit, but it also protects the employee from coming into contact with live parts. The U-RE-LITE automatically opens the circuit at a predetermined point or when ever there is a short circuit or overload on the line. It can be closed again in a jiffy by any man, woman or child . Simply turn the handle:

First to the left, then to the right,
Turn the handle, and U-RE-LITE

U-RE-LITE! Don't call for your electrician.
YOU DO IT!

It is built in capacities from 2 to 200 amperes, for A. C. and D. C. circuits and where so desired can be supplied with Time Lag (Dalite), No Voltage or Shunt Trip Features. It can be adjusted over a wide range both above and below the actual rating as shown on the name plate.

if it isn't an I-T-E it isn't a U-RE-LITE

FUSES ARE GOOD UNTIL USED! THE U-RE-LITE IS GOOD NOT ONLY "UNTIL USED" BUT FOREVER AFTER! BUT THATS NOT HALF OUR STORY. IT'S THE LOSS IN PRODUCTION THAT COUNTS. WRITE FOR CATALOG.

The Cutter Company, Philadelphia

THE

TOWNE SCIENTIFIC SCHOOL JOURNAL

VOLUME 5 OCTOBER, 1921 NUMBER 1

LEADING ARTICLES IN THIS ISSUE

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Foreword

TO THE initiative and enthusiasm of the students who have organized for the purpose of re-establishing the "Towne Scientific School Journal" and to the generosity of the Societies of the School's constituent departments, which have graciously wiped out the deficit left by the former Board during the war, when the publication was discontinued, we are all indebted in the rehabilitation of the "Journal" which is again about to make its appearance.

This magazine is deserving of the co-operation of the University generally and, in particular, of those who are or have been identified with the Towne Scientific School.

It is eminently fitting that its reappearance should be coincident with the academic year 1921-22, which will mark the fiftieth anniversary of the organization of the "Department of Science", which name was subsequently changed to that which it now bears.

Our heartiest congratulations and best wishes go to the new Board in their undertaking which, it is earnestly hoped, will have the loyal support of the students, alumni and faculty.

JOHN FRAZER.

October, 1921.

THE TOWNE SCIENTIFIC SCHOOL JOURNAL

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Reintroducing "The Journal"

FOR several years before the War, the Engineers of Pennsylvania published a student magazine. First, it was the Whitney Magazine, issued by the Mechanical, Electrical and Chemical Engineers. Later, the Architects and the Civils were included and the TOWNE SCIENTIFIC SCHOOL JOURNAL was published.

War conditions made necessary the suspension of publication for a time, but now, with the school larger and stronger than ever before, it is possible to again issue a student magazine.

The purpose of THE JOURNAL is threefold:

First. To unite the students and alumni of the Towne Scientific School more firmly in a line of activity in which all departments have a common interest.

Second. To encourage the reading and writing of technical literature by the undergraduates.

Third. To develop a broader interest in all the branches of the profession of Engineering among the students of the several departments.

The full achievement of this tripartite purpose can only be accomplished through the co-operation of every student and alumnus of Towne. The purpose is in full accordance with the ideals of Pennsylvania—the development of broadly trained, open-minded men—but the ideal can only be approached by practical work.

It is only with the support of every Pennsylvania Engineer that a paper can be issued which is worthy of the name of Towne.

The Assembly Room

THROUGH the efforts of Dean Frazer the Assembly Room on the second floor has again been opened, after serving for a year as a lecture room for the exponents of B. L., F. and A., P. S., and most of the rest of the alphabet. In other years the smoking room was the chief of the many features which distinguished Engineering Building from the other buildings on the campus. No other department has any such provision for the members of its student body to meet outside of class hours, and Engineers are justly proud of this distinctive opportunity. If we see another Engineer putting his feet on the new upholstery, we're going to jump on him just as if he were a Wharton man. Engineers don't kick holes in the furniture at home, so why should they do it at school?

And to the Freshmen

GOD gave fleas to the dog just to remind him that he is a dog; editors give advice to the Freshman just to remind him that he is a Freshman. But to be a Freshman is the best thing that can happen to a man.

The biggest thing that the Freshman must remember is that he is a Pennsylvanian. That may not seem to mean much at first, but as time goes on, it will mean more and more to the man who develops himself into a true representative of the University.

It is rather hard to define in words just what it means to be a real Pennsylvanian. Perhaps this is one of the best: "A broadly educated, clear-minded, straight-thinking gentleman, with a love and reverence for the traditions of Penn."

Freshman, get to know your University—its past history; its present activities. A well-balanced education can not be obtained in the classrooms and the library. Know your classmates, and make up your mind that before you graduate you will do something for the advancement of your University. Athletics, publications, Mask and Wig, Philo—none of the many branches of undergraduate activity are outside of the field of the Engineering student. The man who, because he is an Engineer, confines himself to Engineering Building is missing the best opportunities that Pennsylvania has to offer. It is quite possible for a man to do all of the work that is necessary for his technical training and still have time to develop himself along broader lines.

The man who is the best Pennsylvanian will make the best Engineer.

Publicity

LAST Spring a short course in Highway Engineering was given under the auspices of the Civi Engineering Department and the Pennsylvania State Highway Department. This, and the Conference which followed, brought the most prominent Highway Engineers in the East into direct contact with the University. The opportunities for improving the already high standing of the Towne Scientific School by favorable publicity were tremendous, yet the Conference received only a few short notices in the down-town papers, and funds for printing its proceedings were not appropriated by the Trustees of the University.

A week or two ago some one seemed to think that a *Punch Bowl* editorial was serious which is almost as bad a mistake as to think that a *Punch Bowl* joke is funny. The city press came out with columns of sensational articles, and prominent alumni and trustees permitted themselves to be quoted in hysterical interviews which only served to add to the unfavorable publicity which an otherwise almost unnoticed incident gave to Pennsylvania

Anything which savors of the sensational is welcome news to the Philadelphia papers; events at the University which might really serve to add to our prestige are often practically neglected.

Perhaps it might be well for students to remember this before acting, and for officials to remember it before speaking.

We Thank You

THE BOARD, in this first number of the revived JOURNAL, wishes to express its appreciation of the efforts of those men who made its publication possible.

Dean Frazer, by his encouragement and official support has done everything possible to make the JOURNAL a success. The advice and suggestions of Professor Morris, acting Faculty Adviser, have been of great value to the Editors. The Directors and the other members of the Faculty to whom we have appealed for aid have all given us their heartiest support.

The co-operation of the departmental societies and the Men About Towne was most willingly offered at the time when the revival of the JOURNAL was discussed and was given when it was most needed.

Gentlemen, we thank you.

P. E. I.

THERE is an infinite number of excuses which may be used by the man who isn't doing anything on the campus. Some of them are pretty good excuses; most of them are not so good. But at the best, only a few of them are real reasons. It's quite easy to hunt around for excuses—if you hunt hard enough you can find an excuse for anything from murder up to cutting a class in Descrip. But it's pretty hard to find a real reason for doing either of these things.

One of the easiest things to find an excuse for—and one of the hardest things to find a reason for—is the Department of Physical Education. And it's not the fault of the Department that it is as it is—it's altogether the fault of the several thousand students who think that a gym. class is the easiest way to get credit in P. E.

"You're a pretty husky sort of boy. Why aren't you rowing?"

"Oh, I'm an Engineer. We don't have time to go out for Crew."

Another excuse—not a reason. Did you know that five out of eight of last year's 'Varsity Crew were Engineers? Did you know that for three successive years the Crew captain has been an Engineer? And Engineers don't have time to row!

Almost any one will agree that the most unenjoyable way to waste an hour is to heave around the dumb-bells in Weightman Hall. Yet almost every one does that very thing when he might be getting gym. credit in any one of a dozen different ways.

The Engineer has enough time at his disposal to make any of a score or more 'Varsity squads. This is proven by the success of the Engineers who have already gone in for athletics. Crew, Wrestling, Track, Football, Swimming, Water Polo—these are only a few of the teams on which Engineers are epresenting Pennsylvania. The fun of the competition, the love of the sport, the fight of the contests, the glory of contributing to a Pennsylvania victory, are all elements which cannot be found in even the most spirited session with the Indian clubs. It isn't the satisfaction of making the 'Varsity team that counts; it's the satisfaction of knowing that you've given your best, whether the best was good enough or not.

So let's cut down the representation of Towne on the gymnasium floor. It's a nice sort of place to hold dances, but it isn't such a muchness as a place for forced exercise.

This issue of the Journal is good---we admit it. But the Journal cannot be successful unless it represents the entire Towne Scientific School. Competition for the Board is open to any undergraduate, and lower classmen are especially needed in order to assure a firm foundation of future years.

Help yourself and Towne by helping to improve the Journal.

Measuring Hot Air

William B. Campbell, '22

(Illustrations courtesy of H. S .B. W.—Cochrane Corporation)

IF BY "hot air" we refer to the mental product which is now usually described by the name of a familiar farm animal, it must be acknowledged that there is no known method of measuring it or of estimating its value to the community or to the individual exposed to it. But hot air produced for heating buildings or drying materials has a definite value which should be measured or estimated in some way, while the hot gas going up the chimney of a power plant is a waste product which is habitually investigated in up-to-date plants.

There is many a slip twixt the coal-pile and the shaft or bus-bars and careful management requires a study of where the potential heat goes to; while losses are bound to occur, there are ways of keeping them down. A full study involves the drawing up of a balance, just as a bookkeeper does; the boiler is charged with the heat in the coal used and credited with that in the steam delivered, with the individual losses recorded separately.

The best way to estimate the heat represented by a quantity of coal is actually to burn a sample and measure the heat generated. A sample is taken say from every tenth wheelbarrow, the accumulation is stirred up and divided into quarters, the operation is repeated for one of the quarter piles and so on until a small powdered sample is secured. A gram of this is placed in a calorimeter, together with oxygen under pressure and immersed in water. The sample is ignited electrically, burns completely to ash on account of the excess oxygen present and the heat generated measured by the rise in temperature of the water. This gives a good idea of what occurs in a boiler except for two things:

1. The coal is not all burned under the boiler.
2. Much of the heat generated escapes, instead of going to form steam.

The greatest single loss of heat is up the chimney. The loss cannot be avoided, because we have to burn coal by the aid of air and allow the gases to go up the stack after passing through the boiler, but it is possible to keep down the amount of gas formed and to cool it considerably before it goes out. It would be rather hard literally to measure the gas, but we can tell if the amount is down near the minimum by investigating its nature, that is, by analyzing for the amount of carbon dioxide, in it.

When carbon burns with just enough or with an excess of ai·, it forms CO_2. The equation is a good deal easier than those in Chem. 3; it is $C+O_2=CO_2$. Every molecule of oxygen consumed forms a molecule of CO_2, and by Avogadro's law, not yet repealed, the volume of CO_2 formed equals the volume (not the weight) of oxygen consumed. Now the air coming into the furnace contains only 21% of oxygen, by volume, and if the flue gas contains 18% CO_2, it shows that 18/21 of the oxygen supplied was used. When the CO_2 gets down to 5 or 10%, this shows that only a small part of the air furnished is being used, the rest is simply going through the furnace, being heated up and going to heat the outside world and furthermore each pound of extra oxygen carried through the furnace represents nearly 4 pounds of nitrogen which entered with it and was heated and the heat thrown away. It is impossible to get more CO_2, than 21%, and in practice we cannot get even that much, because with solid fuel there must be an excess of air so that every particle of coal will stand a chance of getting burned. In fact, while the CO_2 should always be as high as possible, indicating a reduced amount of air going through the furnace, there is a danger to be watched out for when it gets above 15%. This may mean that some of the carbon is escaping in the form of carbon monoxide, CO, and carbon which has been burned to CO instead of to CO_2, only generates about 30% of the heat which it should.

Flue gas analysis is a sort of quantitative analysis, and one of the few things chemical which an M. E. can hope to grasp. The special device known as the Orsat apparatus is usually applied in small and medium-sized plants. In this, instead of measuring the CO_2, we take the CO_2 out and then measure what is left. The three small bottles shown in Fig. 1 are shown as pipettes and contain chemicals for absorbing the different constituents of flue gas. The flue gas is drawn in from the left-hand end of the header at the top. When the leveling bottle, filled with water and without any stopper, is held below the apparatus, it draws in flue gas to the vertical burette at the right; when it is raised it forces the gas out of the burette. On starting an analysis, gas is drawn in and then forced out to the air through a three-way cock on the header (not shown in the drawing) and this is repeated until the pipe leading to the apparatus is cleared of old gas and

the water in the leveling bottle and tube is saturated with CO_2. The bottle is then depressed until the water in the burette falls to the lowest graduation mark on it, when the level in the bottle is at the same height and the gas supply shut off. This indicates that 100 cubic centimeters of gas is confined in the upper part of the burette and at atmospheric pressure. The gas is then forced, by raising the bottle, into the first pipette, which contains a caustic potash solution for absorbing CO_2. On returning the gas to the burette, its volume is again measured at atmospheric pressure, The loss in volume is the CO_2, which has been absorbed. This is tried several times until the CO_2 is entirely absorbed and the total loss written down as the CO_2, which was in the gas as drawn from the flue. The potash solution can be used for a long time without becoming saturated. After, but not before, taking out the CO_2, the sample can be shot into the second pipette, which contains an alkaline solution of pyrogallic acid, for absorbing oxygen and lastly it can be forced into the third pipette, which an ammoniacal solution of cuprous chloride, to absorb the CO which may be present. The analysis for CO should be made whenever the CO_2 gets high, on the same principle that we watch out for trouble when we are having a run of good luck.

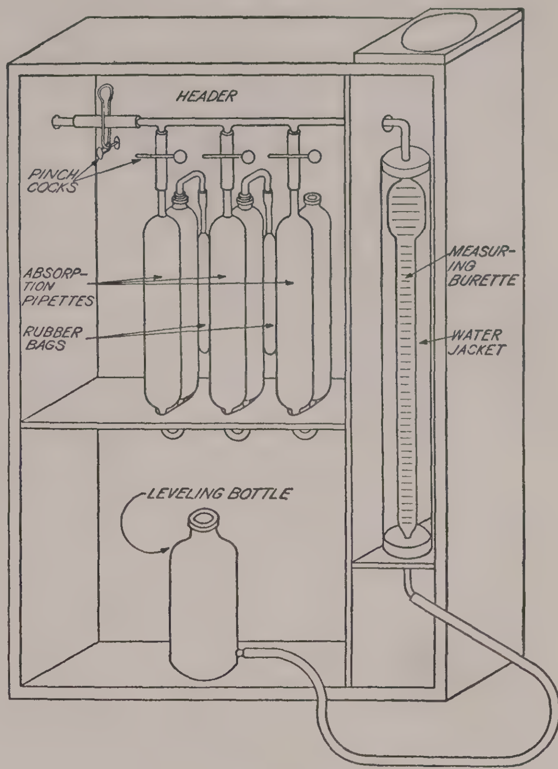


FIG 1. ORSAT APPARATUS

The Orsat might be called the "common or garden variety" of gas analyzer. Since flue gas analysis became popular, all sorts of devices have come on the market for making the analysis automatically, instead of taking a sample now and then and going through the process by hand. Most of these are simply machines for drawing the samples, making the analyses and recording the result. (A machine never leaves the furnace room to get a chew of tobacco nor puts down the wrong figure.) An interesting chart from one of these is shown in Fig. 2. The figures at the bottom represent the hours, the chart being mounted on a drum which turns slowly by clockwork so that the position of the pen corresponds to the time. Every few minutes the machine takes a sample of gas, absorbs the CO_2, measures what is left and drives the pen down to the position on the chart which indicates the amount of CO_2 in the sample. The pen therefore draws a series of parallel lines close together and the imaginary line forming the limit of the shaded area gives a record of the CO_2. The machine also has an electric furnace in which every other sample is exposed, before analysis, to current which causes any CO present to burn to CO_2 (forms same volume of the new gas, Avogadro's law again). These analyses from the gas samples which have been in the furnace will apparently indicate that they had more CO_2 in them than the plain analyses with which they alternate, if any CO is present. The result is that whenever CO is present, every alternate line comes down further

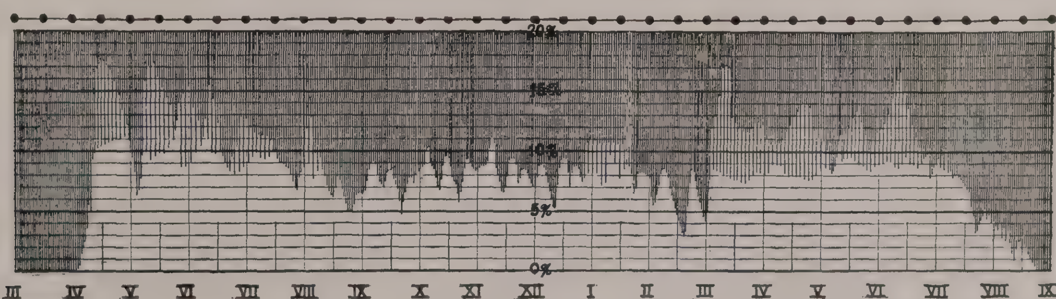


FIG. 2. CHART FROM MONO RECORDER FOR CO AND CO

than its neighbors and there is a sort of "gray" patch formed, as between III and VI o'clock in the right-hand part of the chart. This is a danger signal and means more air must be used, or some other means taken to burn the valuable CO which is escaping.

It is not really necessary to use chemical analysis at all; there are physical characteristics which are just as useful in inferring the composition of the gas. One device has a couple of fans driven by an electric motor, one passing air and the other flue-gas, with an instrument for measuring the pressure differential, which depends on the relative density of the two gases.

Even the different refraction of light in gases can be utilized for anaylsis. In a machine called an interferometer, interference bands from a slit receiving parallel light rays are viewed through two tubes, one containing flue-gas and the other air and the composition of the former judged by the dislocation of the bands from those seen through the former.

It is also true that the amount of CO_2 in a gas can be judged by its thermal conductivity, that is, the rate at which it conducts heat, and some experts of the Bureau of Standards have gotten up an ingenious device for utilizing this principle. The conductivity of the gas sample can be inferred from the temperature reached by a wire passing through it, receiving heat at a given rate, but in this apparatus the temperature is not measured directly, but by the resistance of the wire to the passage of the current creating the heat. As shown in Figure 3, the flue gas passes from 9 to 10, which is a tube containing the resistance wire and then through 11 and 12, which contain material for absorbing the CO_2 and moisture, and through a second tube, 13 and out through 14; 2 and 3 are resistance boxes, 4 a slide-wire bridge and 5 a d'Arsonval galvanometer,

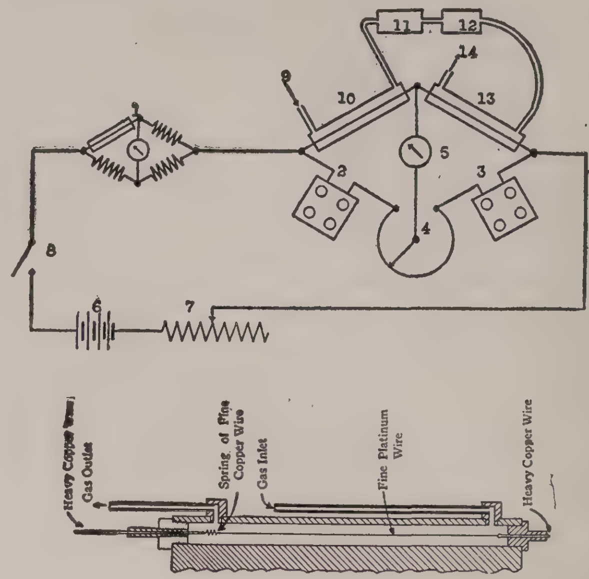


FIG 3. DIAGRAM OF GAS ANALYZER DEPENDING ON THERMAL CONDUCTIVITY, WITH SECTION OF GAS TUBE USED

while 1 is a current adjustment bridge. The initial adjustment required a choice of resistance combinations, but in daily use the per-cent CO_2 is read from graduations on the slide-wire bridge 4, the slide being set to give zero galvanometer deflection.

The making of a complete heat balance is a big contract, involving the determination of the heat taken up by the boiler feed water the full calculation of the heat lost in the flue-gas, together with the unburned carbon in the refuse and in the flue-gas and radiation and other miscellaneous losses. The flue-gas item is however, always the big loss and by far the easiest way to keep track of it is to analysze a sample of the gas.

Engineering and English

MILO S. KETCHUM,

Professor of Civil Engineering and Director of Civil Engineering Department

ENGINEERING has been defined as "the art and science of directing the great source of power in nature to the use and convenience of man". The engineer then must be not only able to construct, but he must be able to design and plan. The engineer must be an artist, a scientist, and a man of broad culture. He must be imaginative and artistic if he is to develop his plans along correct lines, and he must be a man of broad culture if he is to prepare his plans and specifications for the constructor.

The object of an engineering course is to prepare the graduate to enter the profession of engineering as an apprentice, so that he may develop into an engineer. The aim in an engineering course is to give a liberal education with majors in mathematics, mechanics and the sciences, together with fundamental courses in economics, English and modern languages. The engineer not only designs and directs engineering operations, but he must prepare reports on proposed projects, and write specifications for carrying out work. He must have such command of language that he can use exactly the proper word or expression; he must be able to use words not only with scientific exactness but with historical correctness as well. The engineer must acquire a large vocabulary if he is to make the best use of his scientific training. After training in science and mathematics the most important thing for the engineering student is training in language. In fact the training in language is necessary to properly understand a scientific principle or a mathematical proposition. One cannot have ideas without the language to express the ideas.

The engineer should be able to write not only for engineers but for the general reader. In many instances engineering projects fail to materialize because the engineer does not have the ability to present his arguments to the stockholders or to the public in such a way as to carry conviction. The engineer should not only have the ability to carry out the technical details of his plan but should have such facility with language that he may be able to obtain the support of those upon whom success depends, and also that work successfully carried out shall receive proper appreciation.

Due to the importance of the subject, engineering students should receive intensive courses in writing reports and engineering articles and also in technical journalism.

Industrial Preparedness

WALTER T. TAGGART, PH.D.,

Director of the Departments of Chemistry and Chemical Engineering

RECENT years have demonstrated without question of doubt the importance of chemistry and chemical engineering.

The position of chemistry as a key industry makes it of national importance that the chemical industry be fostered and encouraged in this country. But of still greater importance is the fact that our national safety demands that we be prepared. The demands upon future chemists will be greater than ever before.

Therefore, let those who are devoting their lives to the study of this subject realize their responsibility, take advantage of their opportunities and the facilities offered them, and be prepared for future contests, whether they be industrial or otherwise.

PHOTOGRAPHIC SURVEYING

JOHN P. MURDOCK, '22

WITH the close of the greatest scientific war ever known, engineers and scientists began the work of converting the instruments that grew out of the war into peace time utilities. In this reconstruction period nearly all of our former deadly weapons have been stripped of their armor and put to work, in more or less successful efforts to solve some of our peace problems. Of all these changes one that has had excellent results and promises to be most beneficial to man and science is the use of the airplane and camera for making topographic maps, the contour of the country being determined with such accuracy and speed as men never dreamed possible.

The airplane and camera were first combined, during the war, in an effort to locate enemy positions and roads, but are now used to locate contour lines and to give us more accurate maps in a shorter time than was heretofore possible. In contrast with old surveying, this new method gives us overwhelming, detailed information in an amazingly short time. Using a plane, at an elevation of 6000 feet and flying at the rate of seventy-five miles an hour, we can, in an ordinary working day of six hours, obtain all the material for a map of a strip of land four hundred and fifty miles long and one mile wide, or its equivalent. Included in this map would be every road, house, tree and stream, all located beyond doubt.

The airplane used in this work must be of a fairly stable design, with the camera attached to the frame, inside the fuselage. The camera is designed to function without the attention of an observer. Pictures are taken automatically, at regular intervals, according to the height and speed of the plane. The interval between successive exposures is regulated by the pilot who sets a dial to correspond to his elevation and velocity.

It is obvious that if all the exposures were made with the camera in an accurately vertical position, the pictures would give us an actual map of the ground covered. But this is the ideal condition and like all ideal conditions, it is hard to obtain. If the plane dips or is banked; if it slows down or jumps ahead suddenly; or if a gust of wind strikes against the camera, it is evident that the instrument will be jerked out of the vertical and the picture will be distorted. To correct this, the camera is set up in the fuselage of the plane in order to eliminate the action of air forces. It is kept in an approximately perpendicular position by supports that resemble the suspension of a compass box and is prevented from swinging by air checks on its sides. However the camera still deviates from the vertical and correction for this must be made. But instead of further stabilizing the camera, the photographs are corrected by reprojecting the negative on an inclined plate whose inclination is determined by the pictures themselves. Thus it is possible to take the pictures with the camera vertical or, what will accomplish the same result, reproject the negative into a horizontal plane. In this manner the first big fault is corrected.

Another source of error is the sudden dropping of the plane to a lower level. In this case it is necessary to ascertain whether the earth has risen to meet the plane, in the form of a hill, or the plane dropped towards the earth. To solve this the exposures are made to overlap each other. The perspective of two succeeding pictures shows whether the photographs were taken at the same altitude. By the overlapping of one picture on another, stereoscopic differences are formed that, by the use of special instruments, can be converted into a third dimension to give us elevations, the basis upon which our contour lines and topographic maps are built.

Employing this new idea in map making, a great many maps have been corrected and will continue to be corrected with minute accuracy. Places where men could not pass, on foot, through fear of disease or savage tribes, may now be mapped without fear. Thus it is evident that an era in map making is approaching in which results will be more accurate, quicker and cheaper than have previously been realized.

THE MAGNETRON

E. C. HEIDELBAUGH, '22

MR. ALBERT W. HULL gave a very interesting discussion of the latest vacuum tube—the magnetron—in the September issue of the *American Institute of Electrical Engineers Journal.* Preceding this tube were the kenotron, meaning empty; the pliotron, to amplify; the dynatron, giving power; and the magnetron, controlled by a magnetic field.

The ordinary pliotron tube has a filament which is heated to incandescence and maintained at a negative potential with respect to a plate. Since the electrons are negative, and the heated filament increases their

velocity to such an extent that the positive plate will attract them through space, a flow of electrons from filament to plate is caused. This flow of electrons means a flow of current since electron and current flow are analogous in the circuit FBPF.

If the temperature of the filament is kept constant the number of electrons emitted per unit of time will be constant. The number of electrons attracted by the plate, however, is dependent on the potential difference between the filament and plate. As the potential difference between the two increases the current flow increases.

At any instant there are a number of electrons in the space between the filament and plate which are enroute to the plate. The steady increase of the filament temperature will increase the number of electrons traveling toward the plate. The group of electrons in this space produces a negative space charge which tends to counteract the effect of the plate potential. The higher the temperature the larger is the negative space charge.

Now if we put between the filament and plate a mesh of fine wire or a grid, the electrons will be obliged to pass through it. By applying a positive or negative potential to the grid with respect to the filament, it will increase in the first case and decrease in the second the number of electrons emitted by the filament, and increase or decrease the space charge.

The grid thus offers a means of controlling the plate current without varying the plate potential or the filament temperature.

A fundamental knowledge of the operation of a pliotron simplifies the description of the magnetron. It is constructed very much like the kenetron or X-ray tube; its parts, however, are symmetrical with respect to an axis. Two types of tubes have been developed; one with a straight wire filament and a concentric cylindrical anode, the other with a rod anode and a helical filament.

Whether it is a two or three element tube, everything is symmetrical, the reason for this being that it makes it comparatively easy to apply a magnetic field parallel to the axis of symmetry.

The elements of the magnetron are encased in a glass tube, concentric with the electrodes, constricted at both ends, so that a solenoid may be wrapped on them. These solenoids produce a magnetic field parallel to the axis of the filament. The anode is slotted to prevent the neutralization of the magnetic flux by the induced eddy currents. This is especially important in high frequency work.

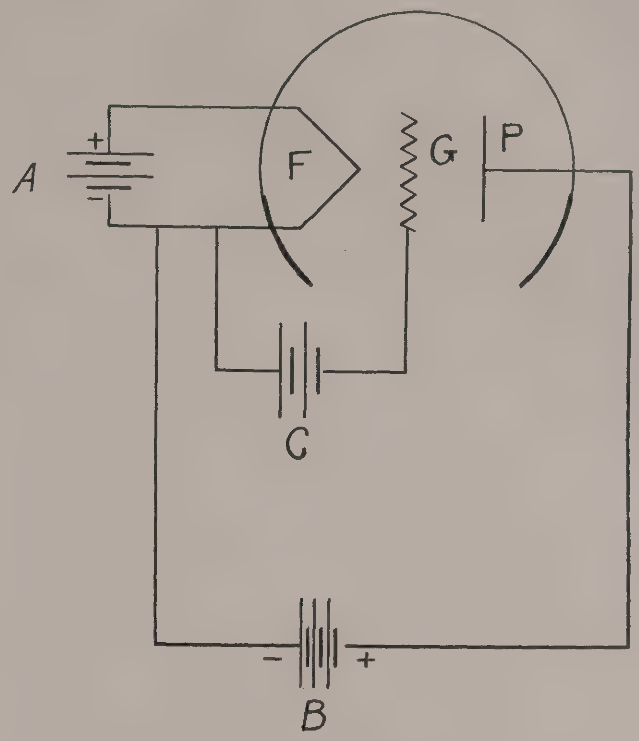


Fig 1. Pliotron Circuit

The electrons start to leave the filament radially, but since they are moving in a magnetic field, they are acted on by a mechanical force, the vector sum of their radial velocity and the magnetic field. This imparts to them a spiral path. The tangential component of their velocity will react with the magnetic field and tend to force the electron radially toward the filament against the impressed e.m.f. If a constant voltage is impressed between the anode and cathode, the current that flows is not affected by a magnetic field weaker than a certain value, but falls off to zero if the field is increased beyond this value. The magnetic field imposes another limitation upon the flow of current beside the temperature of filament and anode voltage of the ordinary three-element tube.

The magnetron is actually being used as a "synchronous detector" in continuous wave radio telegraphy; it can be used as an amplifier, and a generator of high frequency alternating current. In the engineering field it is used as a lightning and surge arrestor. It is only a question of time and development before this tube will be playing a large part in the engineering field.

The Young Engineer

An Interview with Ralph Modjeski, *Chief Engineer Delaware River Bridge Joint Commission*

Edmund F. Burke, '22

"THE mind of the college graduate is, if I may use the comparison, the soil which is prepared for the planting of knowledge. . . " This to a student who had spent three years in gathering the impression that, next to a Freshman, a graduate was the most all-knowing creature on the face of the earth!

"I have hired a great number of young engineers and I have found that, almost without exception, they make very capable assistants provided that they are not started off on work that is beyond their capacity." . . And another air-castle came tumbling down. Of course we had never really expected to be put in charge of the American Bridge Company's construction work as soon as we graduated, but we—being only an average college student—had harbored some sort of a half-hidden hope that within one or two years we might at least be at the head of their work in the eastern part of the country. It seems, however, that we won't—for a while at least.

But the important part of this is not the fact that the quotations from Mr. Modjeski seem to disagree slightly with the high opinion the college man holds of himself, but that a man of Mr. Modjeski's standing is willing to express his opinions and to help with his advice the young men who are making their start in the Engineering profession. Ralph Modjeski has attained by his work a recognition that he is second to none among the Civil Engineers of America. Since their organization on 1892 he and his firm—Noble and Modjeski, Consulting Bridge Engineers, of Chicago—have been in charge of some of the largest bridge construction operations in the country. The bridge over the Mississippi at Thebes and the government bridge at Rock Island are among the many that have been designed and built under their supervision. Mr. Modjeski was also Chief Engineer during the reconstruction of the Quebec Bridge across the St. Lawrence and succeeded in erecting a structure where previous attempts had failed. The large bridge at Memphis, Tennessee, was erected by him, and his most recent undertaking is the new bridge across the Delaware at Philadelphia, which is to be the longest single span in the world. This bridge, which has been talked of at various times since 1818, will be constructed under the orders of Mr. Modjeski as Chief Engineer of the Delaware River Bridge Joint Commission. It is a proof of the bonds of the brotherhood of engineering that such a man is interested in the technical students of to-day.

When asked what kind of a position a man should take when he graduates from an engineering school, Mr. Modjeski answered: "Of course that is a hard subject for generalization. Without knowing the man, or his ability, or his qualifications, it is not possible to say definitely. . . But first a man must select the line in which he wants to work and then get the best position he can in that line—the position which will give him the most varied experience. He might be placed with some big organization as a tracer, for instance, but he would get little benefit from that—going over other men's work. Unless he is certain of promotion a man should not take such a position. But, if he is sure of promotion, a man should work at anything—even as an office boy, if necessary—to gain experience in the line which he has chosen.

"When I graduated from the College des Ponts at Chausées, in Paris, I came to this country to work as Assistant Engineer on the Omaha Bridge for fifty dollars a month. But I had talked with the Resident Engineer and found that I could gain a variety of experience. I got a great deal of knowledge of pneumatic foundations and of the work on the superstructure on this bridge. It is variety of experience that a man must get in his first years of work."

Mr. Modjeski is not afraid that college graduates are being "standardized" by the similarity of the courses in American technical schools. "There are as many types of engineers as there are personalities. I have hired a great number of young engineers, just out of college, and I find that almost without exception, they make very capable assistants, provided they are not given work that is beyond their capacity or education. They know very little, but they have a very good mental training and a little theoretical knowledge that

is of great value to them in mastering the practical details of the work. The mind of the college graduate is, if I may use the comparison, the soil which is prepared for the planting of knowledge. It is well prepared, but as yet there is no growth.

"The confidence in himself that a college course gives to a man is good, up to a certain point. But if he grows overconfident . . . "

"Somebody sticks a pin into him?" was suggested. Mr. Modjeski nodded and smiled.

"The men who graduate with the first half of their class are, as a rule, of almost equal ability and have equal chances of success. Many are of the opinion that the very first men in studies have less ability for practical work, because they grasp things quickly with their keen minds, but do not retain them long. I, myself, graduated at the head of my class from the College des Ponts et Chausées, and sometimes I wish that I had had to work harder for my knowledge—that things had not come quite so easily to me; at times I have a little difficulty in remembering the things I studied. . . But in Europe the students take their work more seriously than in America. They must have greater preparation to enter the technical schools. The subjects—Physics, Chemistry, Trigonometry, Elementary Calculus—which you here in America study in your first two years of college are required for admission to the European engineering schools. Then the students spend four, or even five years in the study of their technical subjects. They put more time on their work. There are no athletics as you have them in the American universities. When I was at School in Paris, if I wanted exercise I did a little rowing, or swimming.

"On account of these differences, the European graduate has a broader theoretical training than has the average American engineer, but the American graduate is, usually, quite well prepared to begin to learn the practical side of engineering."

"How is a man to decide, when he graduates, whether he is to work on some big engineering operation or to go with some smaller organization?" was asked of Mr. Modjeski.

"It depends entirely on the man," was his reply. "He should take the position which will give him the most varied experience in the line in which he wishes to work. There is a great satisfaction in being connected with the large engineering projects that is worth years of work. And a lot of hard work is necessary."

But in spite of the truth of the statement that "the mind of the college graduate is only the soil which is prepared for the planting of knowledge" most of us will go around thinking that we're the whole wheat crop for at least two weeks after we get our diplomas.

The American Society for Testing Materials

F. F. Davis, '22

Illustrations Courtesy of the A. S. T. M.

THE bacteriology professor was lecturing to a class of engineers. "A unit of serum," he said, "is one one-hundredth of the amount necessary to protect a standard guinea-pig—" and he wondered why the engineers laughed.

The students were familiar with the use of the word "standard". They had been constantly referring to Standard Specifications, they had performed many of the standard tests on steel and concrete, but it was rather hard for them to imagine a committee drawing up a set of Standard Specifications to control the manufacture of guinea-pigs.

The standardization of engineering materials in this country has been carried out to such an extent that, in many lines, all but a negligible amount is manufactured under standard specifications. Practically all of this work has been done in the last twenty years, and the results accomplished have been due in large part to the work of the American Society for Testing Materials.

In 1898, a group of the American Members of the International Association for Testing Materials formed what was then known as the American Section of the I. A. T. M., formed primarily to bring about closer relationship among the Americans. During the four years which followed, the endeavors of the American Section took on a much broader scope than that of the I. A. T. M. This difference made the work of the

FIG 1.

new section more difficult and it was due to this that the American Section was incorporated in March 1902, under the laws of the State of Pennsylvania, as the American Society for Testing Materials. Among the seven incorporators were men whose names are familiar to Pennsylvania Engineers. The founders were Henry M. Howe, publisher of many technical works; Charles B. Dudley, then chemist of the Pennsylvania Railroad and a pioneer in the study of Materials; Edgar Marburg, who was Professor Ketchum's predecessor in charge of the Civil Engineering Department; Robert W. Lesley, to whom we are indebted for our modern Cement Laboratory; Albert L. Colby, William R. Webster and Mansfield Merriman, whose textbooks are known to every student.

The purpose of the Society is stated as "The promotion of the knowledge of the materials of Engineering and the standardization of specifications and methods of testing."

In arriving at this purpose the Society encourages individual investigations by its members and publishes the reported results. This however is not sufficient and Committees are appointed whose object is to make a thorough investigation of the materials, for general knowledge, for standardization of specifications and for standardization of methods of testing. The latter is in many cases as important as the second item mentioned. This fact may be more deeply impressed by calling attention to the methods of testing Portland Cement. Widely varying results are obtained by slight variations in the preparation and performing of the tests.

Before the organization of the A. S. T. M., conditions in the field of engineering materials were such as to discourage the development of many large industries. For example, a small railroad in the West would want structural steel to comply with certain specifications. Some other company would want its steel to be of a slightly different composition, the difference in many instances being based merely on the personal opinion of the engineer in charge. These differences were minute, but there were so many sets of specifications that it was impossible for any manufacturer of structural steel to stock up for future orders. Now that the A. S. T. M. specifications are so widely used, it is possible for the manufacturers to work through the slack season and carry on hand a stock sufficient to fill any reasonable order immediately. This results in more efficient plant operation, giving cheaper production and a uniform product.

In every field the same condition prevails. The list of the specifications contained in the latest edition of the A. S. T. M. Standards shows the wide scope of the society's operations. The 160 standards so far adopted by the Society include:

61 Pertaining to Steel and Wrought Iron
7 Pertaining to Pig and Cast Iron and Finished Castings
31 Pertaining to Non-ferrous Metals.
18 Pertaining to Cement, Lime, Gypsum and Clay Products.
10 Pertaining to Preservative Coatings and Lubricants.
19 Pertaining to Road Materials.
4 Pertaining to Coal and Coke.
6 Pertaining to Timber and Timber Preservation.
2 Pertaining to Rubber.
2 Pertaining to Miscellaneous Subjects.

Among the tentative Standards proposed by the Society, but not yet finally adopted, there are, in addition to many relating to materials included in the above list, also several relating to Waterproofing, Shipping Containers, Insulating Materials and Textiles.

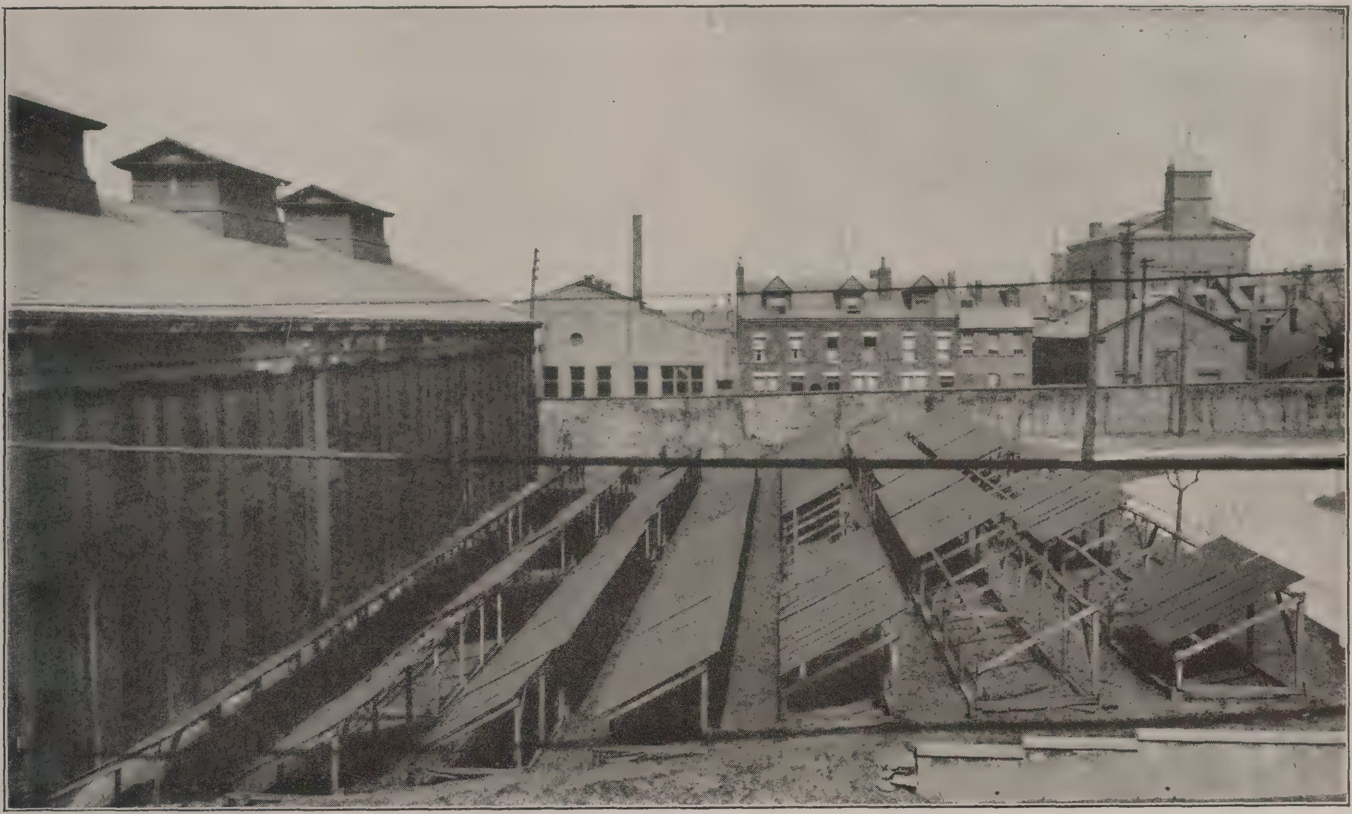


FIG. 2. CORROSION TESTS ON SHEET METAL

The final form of any standard is only arrived at after years of investigation and experimentation. In brief, the adopted standard is arrived at as follows:

The Executive Committee of the A. S. T. M. appoints a committee of men who are thoroughly fitted for the investigation of the particular subject and familiar with what is good practice. Where the subject has a commercial bearing, equal representation is given the manufacturer and the consumer. For in order to arrive at a specification that will be accepted by the majority it is imperative that all interested parties be brought together. Every effort is made to specify a material that will meet all the requirements of the service in which it is be to used and will, at the same time, be possible to manufacture at reasonable cost. The committee reports on its work from time to time and when it thinks it has reached a satisfactory standard draws up a specification which is known as a Tentative Standard. This is printed in the Proceedings for one or more years, in order to invite criticism and suggestions, which are given due consideration by the committee before the Tentative Standard is recommended for final adoption. The vote for final adoption is by letter ballot.

The method of carrying on the tests is very interesting even to one who is not familiar with such experiments. One very interesting investigation of the Corrosion of Iron and Steel is now in its fifth year and is still unfinished.

In this investigation iron and steel sheets of different gages and of varying compositions were exposed to the natural elements at three locations, Pittsburgh, Pa., Fort Sheridan, Ill. and Annapolis, Md. These stations were selected because of their different atmospheres.

The Pittsburgh test was first to be started and is now nearing its completion. At 16 months no failure was reported for the light gage copper bearing metal while 35% of the non-copper bearing metal had failed. At 28 months the failures reported were 41.1% for the copper bearing sheets and 91.6% for the non-copper bearing sheets. At the end of 52 months the failures reported were 63% for copper bearing sheets and 97% for the non-copper. The heavy gage copper bearing metal has not failed at all while that containing no copper has 42% failure.

The investigations installed at Fort Sheridan were later than those in Pittsburgh but so far the failures

FIG. 3.

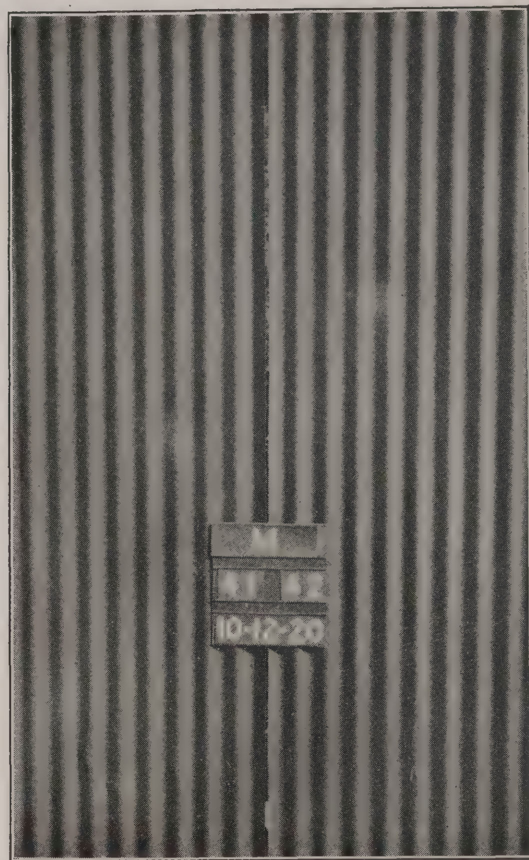


FIG. 4.

follow those at Pittsburgh. As yet no failures have occured at Annapolis. Figure 2 shows the method of exposure followed at Pittsburgh and Fort Sheridan. Characteristic failures are shown in Figures 1, 3 and 4.

The results arrived at so far show conclusively that copper bearing metal is far superior to the non-copper bearing metal in rust-resisting properties although the two are of the same general composition. The results at Pittsbuigh and Fort Sheridan are so similar that the conclusion drawn is that the two different atmospheres have shown substantially the same general tendencies.

Sub-Committee I carried on a series test af the action of mine waters on No 22 gage and No. 16 gage metal sheets These test pieces were immersed in water pumped from the Calumet Mine Calumet, Pa. The water contained large amounts of sulphates of iron and aluminum. The acidity of the water averaged about 740 parts in one million parts of water. Complete failure of all the test pieces was reported.

This investigation is just one of numerous ones which are being carried on all the time. And it is these detailed studies of the various materials under all possible conditions that make possible the drawing up of the standards that we use to-day.

The publications of the Society include the annual proceedings, which include committee reports, technical papers, tentative standards and discussions; the Year Book, containing general information concerning the Society; and the Book of A. S. T. M. Standards, published every three years, which contains the standards so far adopted. A new edition has just been issued which contains 160 standards.

Membership in the Society is open to all who are interested in the production or use of engineering mateiials and now include neaily 5000 engineers, technologists, manufacturing companies, public and private utilities, municipalities, highway departments, university faculties, etc. There are two classes of membership—Members, who are persons over 27 years of age, corporations, technical societies, teaching faculties and libraries and Junior Members, who are persons under 27 years of age. Privileges are alike, except that Junior Members are not allowed to hold office.

The University of Pennsylvania has always been actively interested in the great development of the A. S. T. M. from 1902. Until the growth of the Society made larger quarters necessary, in 1918, the offices were in Engineering Building. Professor Marburg was for sixteen years Secretary. Professor Berry is quite active in the Society and is now chairman of the Lime Committee. The present Secretary is Mr. C. L. Warwick, formerly of our Civil Engineering Faculty. The offices of the Scoiety are now in the Engineers Club Building.

Technical Advertising

By W. B. Spooner, Jr., B.S. in Ch. E. 1914

Manager Research Department—Chemical and Metallurgical Engineering.

THE subject of technical advertising—or advertising addressed to the technically trained reader, has taken on new significance since the outbreak of the war. The enormous growth of the industries in which the engineer is in control has been responsible for a corresponding growth in the power of the engineer. The advertising by which a manufacturer of equipment or materials used in these industries reaches these technical executives has consequently assumed an important position in the advertising field as a whole.

The following pages will attempt to cover in brief a few of the more important phases of technical advertising and its relation to advertising as a whole. It will be understood, of course, that in the space available, the treatment of the subject is necessarily much curtailed.

First, it is necessary to place technical advertising in its proper position. When you read a Mennen's Shaving Cream "ad" in the Satevepost—dash madly over to Beaston's and, in response to Jim Henry's convincing arguments, buy a tube at once, one very important kind of advertising has got across. You have been effectively sold by that "ad", whether you're plugging away in the E. B., or Logan Hall, or the Law School, or up at the Dental School. The advertisements of Mennen's Shaving Cream, or Jordan Motor Cars, or Goodyear Tires, are addressed to a general audience. These "ads" may be classified as national advertising. They appeal to all classes of readers. They usually appear, moreover, in publications read by all sorts and conditions of men—plumbers and professors, policemen and druggists, grocers and embalmers. These publications are usually called General Media.

But there is another kind of advertising. The grocer has his peculiar problems—so has the druggist. Both are anxious to increase their business and to learn more about methods that will help them do so. Hence, there are publications which keep these men posted on the methods used by other grocers or druggists to boom their businesses. These papers are extremely important factors in the business life of the couutry. They are called trade papers, for that is exactly what they are. All kinds of businesses have them—including the undertakers.

The advertising in these trade papers is more specific than that in general media. It bears in mind the special problems of their readers. It cannot be addressed to a mixed general audience, but must get down to brass tacks—to the business of its readers. It is designed to sell its readers the equipment they use or ought to use in their business.

Now we come to technical advertising. In the minds of many advertising men, concerned chiefly with general advertising there is no real difference between a trade paper and a technical paper. They lump them all together.

Now you, as engineers, know that however involved the problems of the grocer or the undertaker may be, your profession and the methods tending toward its advancement are far more involved and on a much higher plane. You read your technical papers—not to learn how to sell more bridges, or to get more orders for sulphuric acid, but to keep in touch with the new methods, the new machines and the new materials developed in your field. You cannot afford to neglect the business aspects of your profession, either. You must know all you can about methods of cutting production costs, of handling men, and of producing satisfactory profits. You must keep in touch with business conditions. Your technical paper gives you this kind of information as well as purely technical articles.

Advertising in these technical papers is not so much an urge to act at once and "order that steam shovel", as it is to keep you posted on what the newest designs in steam shovels are; what they do and their advantages when used in your particular professional

work. Technical advertising is decidedly in a class by itself—it is radically different from, and on a much higher plane than, trade paper advertising. (Not that all of it measures up to this standard. But the standard is there!)

Let's look at it from a little different angle. General advertising usually has a direct buying stimulus somewhere in its makeup. It may be an ad for a motor car, or for a soap. Being addressed to a general audience, its appeal is designed along lines which will influence the largest number of that audience. Trade paper advertising has a narrowed appeal—a smaller audience, but a picked one. It is still addressed to a somewhat heterogeneous audience. Grocers are not shaped in a common mould of training as are the engineers. Trade paper advertising has a specific appeal, but just as its readers have no especial training, little is required to write it. All that is necessary is a knowledge of the trade for which the advertising is written, and of the uses in that trade, of the product to be advertised. Technical knowledge is rarely needed—or usable.

Good technical advertising, however, is entirely different. It is addressed to engineers. You cannot rave on about the beautiful hum of a "Whoozis Generator" operating under full load, or of the joys of neutralizing an acid solution with "Killzit Caustic Soda!"

You cannot, moreover, use the trade paper appeal, and tell your readers that "Excello Filter Presses" are quick movers and great profit makers, or that "Breezon Transits" help sell bridge steel faster. You are addressing the engineer. He isn't going to wire you an order "*rush*" after he reads your ad. If he needs a product such as you manufacture at the time he reads your ad, you haven't much chance of selling him unless your product is quite revolutionary. Technical advertising must present the engineering aspects of your product so convincingly for the engineer, that when he needs a similar product your own will be firmly impressed in his mind as a pretty good article for his purpose. Hence, unless he has known your product in the past, your chance is slim of selling him with *one ad*. In the case of such equipment as conveyors or elevators, or industrial trucks, technical advertising can help convince the man who is using hand labor of the value of such material handling equipment in his plant. In other words technical advertising can and should be an educational force to persuade men to adopt better methods.

It is obvious that no one can write really convincing technical advertising unlesss he knows the technical side of a product—he must know how it is used and why it is used and what it does. A layman can write good technical advertising—many do. But this is only after they have studied and worked hard to get the technical viewpoint. Not all engineers can write good technical advertising either. The writing of advertising is a special art—whether trade, general, or technical. However the engineer able to write does write, as a rule, far better technical copy than any layman. He knows what he is writing about and the kind of men who will read what he has written.

Now let us see how advertising—particularly technical advertising, is sold, written and prepared for publication.

Perhaps the best way to do this is to pull the old hypothetical case stuff. Suppose you are a manufacturer of pumps. Now, pumps are used in a wide variety of industries—practically everywhere, in fact. Pumps are not exactly interchangeable, however. One type is good for one job—where another type would fail. You make a pump, let us say, that is suitable for process liquors in chemical plants and in manufacturing plants in general. It wouldn't do very well in a mine, or in a hotel, or for high pressure work. In other words, you have a large field, but a limited application. You have been selling pumps for many years but never have advertised. Of course as a matter of fact you would have been approached time after time by advertising salesmen long before this hypothetical start! You would have had calls from the men who sell space on the general media—and the men who sell space on trade papers and the men who sell space in technical papers! The chances are that you would even have had appeals from advertising solicitors representing publications devoted to the sale of women's wear! Business is business and some solicitors look no gift horse in the mouth, provided they can persuade you to give them the horse!

But you are not exactly a philanthropist. You know what you expect from your advertising—and you have a fairly good idea of the field in which your product can be sold. Moreover, you probably have a limited amount of money to spend.

When it comes to making a decision on your advertising, you will pass up the general media entirely, in all probability, because their large circulation makes their cost so high that the small number of actual prospects for your product who are reached by this advertising would not pay. The technical paper solicitor has the easiest path to your product because the readers of this paper as a whole are the men who buy, or influence the buying of your pumps. There are many technical papers in which you can advertise—and they'll all be after your business with live wire

salesmen. At the same time there are some trade papers in which you should also advertise if your product is distributed through jobbers and dealers, instead of direct.

If you have a large advertising appropriation—if you can afford to advertise in a great many papers—you'll find probably that it would be wise to let an advertising agency handle your account. It will advise you on your markets, your sales appeal, your whole sales problem. It will also write your copy—select the media you should use—and in general take care of your advertising. In any case you'll be visited by advertising solicitors!

Finally, of course, the media will be selected either by you or by your agency and the number of pages to be used in a year decided upon. You'll still be visited by the salesmen of the papers you didn't select and by those other papers which have just decided that you are a prospect. (This will keep up, moreover, as long as you are in business.)

You have decided, however, on a certain number of technical papers. From now on we'll consider just one of them, in which you have decided on a full page every other issue. That means 26 pages of advertising, for it is a weekly. You know how your pumps are used in these industries served by this paper, or at least you do in some cases. (Often the equipment manufacturer only knows that his equipment is sold in these industries, without having any real idea of its use.) The next problem is to prepare the copy to be used in the space you have contracted for.

You may write this copy yourself. Many manufacturers do. An agency, if you have one, could write it, or the copy department of the magazine selected will usually do it for you.

Your product, where real technical copy is prepared, must be studied from the viewpoint of its use in the industries served by the publications selected. Unlesss you are a very large manufacturer with an Advertising Department of your own, you will not have the facilities for preparing the kind of copy that should be prepared. Therefore, as a rule it will either be the Copy Department of an agency, or of a magazine that will handle it.

In a series of ads, whether they are actually connected or not, the selling points of your pumps and sales plan must always be borne in mind. Points of superiority and the chief differences from other pumps must be picked out. Your market and your sales appeal; your price and your delivery; the advantages and economy of your pumps must be properly considered before writing an advertisement. The copy writer in other words must make a real study of your product and decide on the motif of the campaign he will prepare for you. Once he has an idea for a series of ads he is able to proceed with the layout or layouts for your campaign.

The preparation of a specific page of copy consists in indicating roughly where the headline or opening part of the reading matter and the reading matter itself appear; where the illustrations, if any, will be used; and where any other features of the advertising are to be located. This is called a layout. It is then usually given to the Art Department—which prepares a finished suggestion for your approval. The copywriter of course writes appropriate copy for the space for reading matter, always considering the size of type to be used, and the legibility and attractiveness of his copy.

If the copy writer has decided to use a drawing, an artist makes one according to the former's directions. If the ad is to be illustrated by photographs, the proper sized photo is inserted in the suggestion where it is indicated. In the meantime, of course, the copy writer has written the headline and copy itself.

You will then have submitted to you the finished suggestion—or the series of suggestions which are to be used in your campaign in a particular paper. If you are like the average advertiser a great deal of it suits you—and a lot of it is absolutely wrong! Sometimes you know what you are talking about and sometimes you are just playing whims and personal dislikes. At all events, you go over the finished suggestion with an axe or a feather duster as suits your temperament and the remains are shipped back to the agency or magazine—ready for reproduction with your O. K. These ads are then "set up" or prepared for the printer, the type being set and placed in its proper position in the size and style indicated by the copy. The illustrations are made into engravings and then set in their places. An impression of the finished ad is then made—and this "proof" is shipped to you for final correction and O. K.

(You can have a nice time here, if you are so minded. There are usually plenty of mistakes for correction!)

But finally the proof is corrected and sent back to the magazine or to the agency preparing it, or O. K'd for final appearance as an ad.

Where many publications are used and the same copy is suitable for two or three of them, it is customary to make electrotypes of the O.K'd type set-up and send these electrotypes to the various papers.

The finished ad is now locked into its proper place in the form—or section of the paper in which it is to

(*Continued on Page 32*)

The New Super-Power Development at Niagara Falls

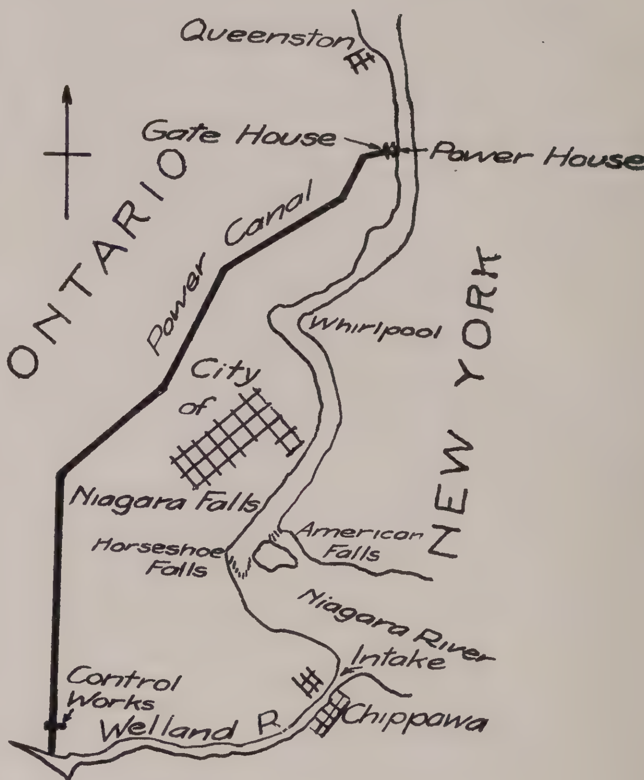
Arthur Willink, '24

THE rapid growth of industries in the Niagara Region have made it necessary to put additional harness upon Niagara Falls. To do this in an efficient way without marring the beauty of the falls, was the problem of the engineers. To construct any more large power plants on the American side was out of the question, because of the fact that the American Falls are drawn from almost to the limit. However, the Horseshoe (Canadian) Falls can have considerable water diverted from them, without marring their grandeur in the least.

It was found that by using the Welland River as a canal for a short distance and then from there to build a canal skirting Niagara Falls, Ontario, to a point a short distance above Queenston it would be possible to have an effective head (height of water) of 305 feet, which is only 22 feet less than the entire difference in level between Lakes Erie and Ontario.

In this connection it might be mentioned that a proposition was made to build a canal across the Niagara Peninsula, but this was rejected because of the large cost involved.

The map shows the location of the Niagara power development which is known as the Queenston-Chippawa Development of the Hydro-Electric Power Commission of Ontario. The project was started in 1918 and is now nearing completion.



Site of Development

The water is taken in at the mouth of the Welland River at Chippawa about two miles above the falls. The river is canalized for a distance of about four and one-half miles, the river being dredged and made trapezoidal in cross section. Near the beginning of the canal is the control works which is capable of shutting all the water off from the canal. The canal is about nine miles long. In order to eliminate as much friction as possible, the entire waterway is concrete lined. The canal is 35 feet deep and its width varies from 48 feet where it is cut through solid rock to 75 feet where it is cut through earth. The cross section in most places is rectangular. The average grade is .02 per cent.

The canal terminates in a forebay, which the water enters under submerged arches to remove any floating matter such as wood or ice and in addition individual screens are provided for each pen-stock (pipe carrying water to the turbine), but there are no individual gates for the penstocks, there being, however, portable gates which can be lowered by a crane over the penstock in case of the failure of the valves below.

The penstocks are of plate steel 14 feet in diameter and 450 feet long. They lead to the power house at the foot of the cliff and each penstock supplies one turbine with water, there being nine in all. At the foot of each penstock, there is the Larner-Johnson hydraulic operated valve which is controlled by the automatic governors of the turbo-generators.

The turbines which are the largest individual units in the world, have a maximum of 60,000 horse power and normally operate at a load of 52,500 horse power and revolve at a speed of 187.5 revolutions per minute. Each turbine discharges downward through a single draft tube.

The turbines are connected to the alternators by means of 31 inch hollow steel shafts. The generators have a rated capacity of 45,000 kilo-volt amperes apiece. They generate three phase 25 cycle energy at 12,000 volts. The field exciters are directly coupled to the main shaft of the turbo-generators. Each generator

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TOWNE TOPICS

FRESHMAN RECEPTION

THE first Freshman Reception held under the auspices of the recently organized Engineering Association proved to be the most successful in the history of Towne. There was an attendance of more than three hundred and fifty at the affair, which was held on Thursday evening, October 13th.

The first speakers introduced by Chairman Ford were three of the prominent members of the Faculty, Professor C. E. Clewell, Dr. Walter T. Taggart and Professor H. C. Berry. Much was said that impressed upon the Freshmen the high standing of Towne men on and off the campus.

Captain Rex Wray urged upon the new men the importance of Pennsylvania spirit. Paul Patton, of the Soccer team, and "Eddie" Mitchell of the Crew were the other major sport captains who addressed the students. Towne activities were introduced by "Eddie" Burke, of the JOURNAL, and "Charlie" Simon, of The Men About Towne.

Splendid entertainment was provided by the Musical Clubs Quartette, the student orchestra, and some prominent Engineers from Mask and Wig. The concluding speech of the evening was an address of welcome by President McAnally of the Engineering Association. The meeting then adjourned to food, music and smokes.

The success of the smoker promises well for the future success of the Engineering Association, which makes such co-operation possible.

WHITNEY ENGINEERING SOCIETY NEWS

Due to the confusion and excitement usually accompanying the beginning of the semester, a definite date has not been decided on for our first meeting. However we are expecting to hold one in the course of a few weeks.

Membership cards are in the hands of the printer and will be ready in time to make our drive soon after the Freshman reception.

The dues for the year will be $1.25 and will entitle a Whitney member to membership in the Engineering Association. We are expecting to enroll every M. E. student in this Society.

HEADS OF DEPARTMENTS ASSUME NEW TITLES

At the meeting of the Board of Trustees last June, official titles were conferred upon the professors who had been in charge of the various component departments of the Towne Scientific School. Previously they had been known as Professors in Charge of Civil Enginering, Mechanical Engineering and so on. At Dean Frazer's suggestion any possible hint of temporariness contained in the titles was removed and henceforth they will be known as Directors of the different departments, this being the practice at the other large technical schools.

A. S. C. E.

No doubt many of the former members of this society will have pleasant memories of some of last year's meetings and anxiously await future gatherings. It is the plan of the officers not to have a society run by a few, but to have every man doing something other than paying his dues.

Our first meeting is to be in the first week of November, when a prominent engineer is to lecture plus a "Surprise" that will warrant the attendance of everybody. We welcome the freshmen to our midst and earnestly hope that they will co-operate with the present officers in making the year of 1921 and 1922 a banner one. A 100 per cent. attendance at all meetings is the first step towards achieving our desire.

THE MEN ABOUT TOWNE CLUB

At the final meeting of the Club last year the following officers were elected:

President—C. Simon, Ch.E. '22

Secretary—W. Boswell, M.E.'22

Treasurer—H. E. Ford, Ch.E'22

The following men who were in the show last year have been elected to membership: J. M. Lipp, C. E. Maris, H. Rowland, A. S. Maris, H. C. Lucas, H. Walker, W. R. Spiller, Adams, J. Lindsay, E. M. Heidelbaugh, J. R. Thorpe, Arthur, A. W. Patterson, J. B. Gallagher, N. R. Guilbert. It was also decided men in the Towne Scientific School with Sophomore standing will be

elegible for election into the Club. This will make it more interesting for Freshman who desire to try out for this year's production.

Men will be needed for the dancing and glee choruses, the cast and orchestra, and it is expected that many of the new men will compete. Members of the dancing chorus will receive gym credit for the first term.

As has been the custom in previous years, the Club is offering a $25.00 prize for the best written musical comedy. This offer is open to any student in the Engineering School.

In addition to the three performances which will be staged in the Engineering Building, plans have been made for several trips this year.

It is acknowledged by the faculty (and clearly seen by the participants in a show) that the working together of men toward a goal is a very great binding and directing force. For this reason, as well as for the sake of recreation, the Faculty always lends its wholehearted support to the Men About Towne Club's annual production. The Show is one of our most representative and enjoyable activities. Support it with all you have: time, talent, money.

A. I. E. E.

The following are the officers of the University of Pennsylvania Student Branch of the "American Institute of Electrical Engineers", for the year 1921-22.

Chairman—Emlen C. Heidebaugh.

Vice-Chairman—Raymond Mooch.

Secretary—John Clothier.

Treasurer—Thomas W. Williams.

All students, especially Freshmen, taking the course in Electrical Engineering, will find it to their advantage to find out what this Society is and to become members of the Student Branch of the "American Institute of Electrical Engineers" located at this University.

As a member, one has a fine opportunity to become better acquainted with the men of his class and other classes and many of the leaders of each class will be found at the meetings. Thus it is possible to keep in close touch with the men graduating while one is still in College, this fact alone being of great value to every student.

The Engineering Association is composed of all the separate departmental organizations such as the Whitney Society, the Civil Engineering Society, the Priestley Chemical Society and the student branch of the American Institute of Electrical Engineers.

The purpose of the association is to make wholly representative decisions on matters of importance on the campus, and to get the whole Engineering School acting as a unit.

The only way this can be done is by every man paying his dues and joining his respective society, thus becoming a member of the association.

So let's all come across with the $1.25 and get going strong!

Chas. G. McAnally,
President.

Leading men in the various engineering professions are secured from time to time as speakers at the meetings. Among other information they give inside dope on what one might expect to run up against as a graduate engineer. Such bits of advice and experience heard now and then may save many a hard bump in later years.

Former members will testify to the enjoyable times to be had at the meetings.

The A. I. E. E. expects the coming year to be the most successful year in its history. Several very important subjects are to be brought up for discussion at the next meeting. All Seniors should become familiar with the new amendment to the constitution affecting them.

PRIESTLEY CLUB NEWS

The Priestley Club opens this year with a membership of about one hundred. The drive of the Engineering Association will undoubtedly double this number and raise the membership above that of any preceding year.

It is easily seen that, with tow hundred or more of the students and faculty of the department eagerly awaiting the first smoke of the year, there will be a decided impetus given to the subject of Chemistry at the University.

While in past years lectures and talks given before the Club have been of absorbing interest, still the subjects presented have been of a highly specialized type and it is thought better in the ensuing year to break away, at least partially from this trend and present subjects of wider interest for the consideration of the Club, such as "Unsolved Problems in Chemistry," "The International Dye Situation," "Conversion of War Time and Peace Time Chemical Industries—and Vice Versa," etc.

It is felt that subjects of this type will be of more real lasting interest and benefit to the young man in Chemistry than a talk on a more highly specialized topic which, while it may mean a great deal to a few, will mean eventually next to nothing to the great majority.

During the coming year it will be the problem of the executives elected at the end of last year to procure representative spearkes and furnish entertainments that really entertain.

ALUMNI

The Engineering Alumni Society held its annual meeting last June. At that time the following officers were elected for the ensuing year:

President—R. L. Humphrey, '90

Vice-President—D. R. Yarnall, '01

E. W. Smith, '97

Secretary—Wm. C. Wetherill, '10

Treasurer—W. S. Evans, '07

At this meeting it was tentatively decided hereafter to hold the annual meeting sometime during the middle of the school year instead of at the end. It was argued that in June many men are out of town, that the weather is too hot and that the Seniors, whose attendance is desired, are too busy with final examinations and graduation exercises.

It was also decided at this meeting to issue sometime during the following year the "Engineering Alumni Catalogue." This contains a record of the proceedings of the Society's meetings, and also a list of the names, addresses and occupations of all the alumni of the Towne Scientific School. The last issue of the "Engineering Alumni Catalogue", was published about 15 years ago.

Many students are unaware of the existence of the "Engineering Alumni Society". The purpose of the Society is twofold. First, to bring together and keep in touch with "Old Penn" the various graduates of the Engineering School. Secondly, to help men through college who are in need of financial aid. The Society helps students to secure positions during the School Term and over the vacation period and also extends direct financial aid from its own Treasury to deserving students.

All Seniors in the Engineering School are cordially invited to attend the next meeting of the Society, so that they can become acquainted with the personnel and work of the organization.

Personal Notes

Arthur M. Greene, M. E. '93, has been appointed Dean of the new School of Engineering at Princeton University. Dr. Greene will go to Princeton with a record of distinguished service in engineering education. Ranking among the leaders in mechanical engineering by his experience and achievements, he is especially qualified for the important service which he is to undertake at Princeton. He has been engaged in educational work for the last 30 years, having been Professor of Mechanical Engineering at Rensselaer Polytechnic Institute since 1907.

Henry R. Towne, '85. Announcement has been made of the election of Henry R. Towne, head of the Yale and Towne Manufacturing Company, to Honorary Membership in the American Society of Mechanical Engineers. Mr. Towne has been a member of the Society since 1882.

George D. Rosengarten, '90, was chosen as one of the directors of the American Chemical Society, of which Dr. Edgar Fahs Smith, former Provost of the University, is president, at a recent meeting of the Society.

Norman F. Brown, '01, former assistant chief Engineer of the Pennsylvania Railroad system, has been appointed Director of the Department of Public Works.

Dr. Allen Rogers, '02, of the Department of Chemistry of Pratt Institute, Brooklyn, N. Y., was chosen as one of the Councilors at a recent meeting of the American Chemical Society in New York.

Clyde B. Pyle, '11 C. E., is connected with the firm of McClintic-Marshall Company, of Pittsburgh, Pa.

Harold Kitson, '13 M. E., is the senior partner in the firm of Kitson and Kitson, Life Insurance, Sixth and Walnut Streets, Philadelphia, Pa.

(*Continued on page 30*)

The Liquid Fuel Situation

A. L. Robinson, '23

THE principal source of liquid fuel, fuel oil and motor fuel, has been petroleum or crude oil, ever since it was discovered in abundance in Pennsylvania in 1859.

The gasoline content of petroleum is about 20% and is obtained by fractional distillation of the crude oil—slowly heating it and collecting separately the portions or "fractions" that pass off at different temperatures. Naphtha, which when freed of its more volatile components gives gasoline, passes off below 75°C; from 75° to 150° is the benzine fraction; and roughly between 150° and 280° the kerosene fraction. These are the so called "light" oils. Above are the heavy lubricating oils and paraffins.

In 1920, 440,000,000 barrels were produced and in addition 110,000,000 barrels had to be imported, mainly from Mexico, to make up the deficit in home production. While our output has about reached its maximum, the consumption is naturally increasing yearly, due to the annually mounting numbers of automobiles, trucks, tractors, and the newly opened field of aerial navigation. At this point the U. S. Geological Survey announces that at present rates of production our crude oil supply will be exhausted in about 15 years. In 10 or 20 years then, this country will be entirely dependent on outside sources for its supply of liquid fuel for motor transportation, and generation of heat and light for farms, unless new sources of petroleum are discovered or substitutes for gasoline and its allied fuels are developed.

It is for this reason that attention has been recently turned to oil shales and the problem of extracting oil from them. Oil shale is a shaley deposit from which petroleum may be extracted by distillation, but not by any solvent action. It occurs in practically unlimited quantities in various parts of the world, Scotland, France, New Zealand, Australia, the Transvaal, Spain and elsewhere. The deposits in Colorado, Wyoming, Utah and Nevada are particularly large and rich in oil-forming material and could supply this country for several generations.

The nature of oil shale is doubtful. It may be dried up petroleum, or it may come from organic matter, vegetable and animal, by the action of microbes under special conditions. But it is there and ready to be worked. France and Scotland have experimented with them, also New Zealand, but none of the large deposits, except the Scottish oil shales, have as yet been worked with complete success. In this country the work thus far has been entirely experimental.

The distillation of the finely powdered shale in large iron retorts does not yield oils directly. Up to 600°C there is no noticeable change, only small amounts of light oil passing over, but between 400° and 410° a solid or semi-solid bitumen is yielded. (A bitumen is a natural hydrocarbon containing small amounts of oxygen, nitrogen and sulphur and is largely soluble in carbon disulphide.) The gasoline and other light oils are the result of the further decomposition or "cracking" of this bitumen at still higher temperatures. Distillations of samples of Colorado shales have given 700 pounds of oil per ton of shale, far from a maximum yield, but still satisfactory.

The gasoline obtained from shale oil is not as satisfactory as petroleum gasoline. It is unsaturated to a great extent and must be blended with a saturated oil before it can give good service as a motor fuel. It is similar to the gasoline obtained by "cracking" heavy petroleum oils and residua. With this latter product it can compete. As the demand for gasoline increases, refiners are meeting the question temporarily by cracking heavy petroleum oils to produce gasoline. But the other petroleum fractions, kerosene, lubricating oil, fuel oil, wax, are also needed. So that it is the shortage of crude oil, not gasoline itself, that threatens. As this cracking of higher petroleum fractions is resorted to more and more, shale oil as a source of motor fuel will compete favorably and will allow the other petroleum fractions to be used normally. Moreover it has great possibilities as a fuel oil.

Benzene, which is a product of the distillation of bitminous coal, when mixed with gasoline makes an excellent motor fuel, giving a mileage equal to that of gasoline and a very smooth operation. But even if all the bituminous coal mined in the U. S. yearly were treated to produce benzene, the yield would be only 20% of the amount of gasoline used annually. In fact the present production is only 3% of the amount of gasoline used. So that the possibility of utilizing benzene as motor fuel is more interesting than practical.

Alcohol as a fuel oil has found wide and satisfactory use. It has also been used as motor fuel and has been found to possess certain advantages. Its combustion is very clean, depositing no carbon in the combustion chamber; it stands very high initial compressions without knocking and can be used smoothly and evenly at high pressures, thus increasing the available horse power of a definite sized motor run by gasoline. On the other hand, its heating value—20,000 B.T.U. per gallon—is much lower than that

of gasoline—120,000 B.T.U. per gallon. But, because alcohol does not knock, this disadvantage can be overcome by higher initial compressions, high enough to increase the thermal efficiency of alcohol to equal that of gasoline. The U. S. Bureau of Mines has shown that gasoline run at 70 lbs. per square inch initial compression and alcohol at 180 lbs. have equal fuel values. To produce this high initial pressure though special devices would have to be added and practically every motor would have to be changed to utilize alcohol as a fuel.

As the production of alcohol increases however, while that of gasoline decreases, experimental changes which are being made are bound to find general application. At present the question is not—how can the motors be changed?—that is comparatively easy. The problem is—where is the alcohol to come from?

The production of alcohol in the U. S. is about 100,000,000 gallons a year, only about 2% of the volume of gasoline consumed at present. The principal source of alcohol is the blackstrap molasses left in the refining of cane sugar. The yield from this source can not be increased very much. Other sources are starchy foodstuffs, as corn and waste cellulose—containing material such as wood. The utilization of cereals to produce alcohol in such large quantities as are needed would be tampering seriously with the nation's food supply.

But cellulose (which contains the same proportions of carbon, oxygen and hydrogen as starch) in some form or another will solve the problem. It is known that wood, which contains about 50% cellulose, when boiled with acids is converted to dextrose, a sugar. The latter on fermentation with certain minute living organisms (yeast is in this class) is converted into alcohol.

There are at present two plants operating in this country manufacturing alcohol from wood waste. They have obtained a yield of 20 gallons of alcohol per ton of wood at a cost of about 25 cents a gallon. At this rate too much wood would be required to produce the 5,000,000,000 gallons of motor fuel consumed annually, taking into account freight costs and the large quantities of acids necessary to the process. But the theoretical yield of alcohol from a ton of wood is about 70 gallons. Any process giving from 50 to 60 gallons per ton would be highly satisfactory. This part of the task is up to the chemist and he will undoubtedly solve it within the next 10 years; 100,000,000 tons of raw material will be required annually; the supply should be constant throughout the year and the distance over which it is to be transported to the plants should be small. The raw material is fairly abundant and cheap, waste wood, corn stalks, or rapid growing plants rich in cellulose and the expense of labor small, since these tiny organisms or enzymes do the work efficiently and repeatedly.

Alcohol is the motor fuel of the future.

Engineering and Its Relation to Present Artillery Methods

JOHN LINDSAY, '23

Lieutenant 108th F. A.

THE advancement of modern artillery and the accurate methods of firing developed during the late war make it plain that the artilleryman should be a trained engineer. Each branch of engineering contributes in its peculiar way to this training.

First consider the civil engineer. Heavy artillery batteries are usually located in defiladed positions, i.e., on the near side of a hill or in a place which affords protection due to the natural contours of the country, at several hundred yards behind the front lines. The target therefore is invisible from the gun itself. The problem of *orientation* immediately presents itself. The civil engineer knows that this means the calculation of the topographic data. Distances, directions and altitudes must be known before the data for giving the gun the correct elevation and direction can be computed. The methods of making these determinations are nothing more than the methods used in making an initial survey. Transits, levels and all the common surveying instruments are used. Accuracy in this preliminary work is absolutely essential.

If map-firing is to be used the civil engineer is needed not only for the making of the maps, if none are available, but also for the correct interpretation of them. For if accurate maps are at hand the artilleryman can secure immediately the necessary range. During the late war in France many maps were available, most of which were French co-ordinate maps based on the Lambert system of projection. Thus if the co-ordinates of both the gun and target were known, the artilleryman with comparative ease could calculate the range, the accuracy of the determination of course depending on the accuracy of the maps.

The construction of the emplacement and fortification of the gun is also a civil engineer's job. The artilleryman who handles this work might be compared to a resident engineer in charge of construction work. He must be a person capable of planning, supervising and checking the work of locating the

required points, lines and levels, having survey parties, computers and drafts men co-operating with him. He must understand maps, their triangulation systems, construction and projections; surveying instruments and their use, plotting, drafting and sketching; astronomy and its uses.

Again with the railroad artillery the civil engineer is in his prime. The laying of tracks and construction of roads are under his supervision. Location surveys of connecting tracks and of epis (firing tracks) are made by him. The methods used by this branch of the artillery are worth noting. From the connecting or main track the railroad mounts are switched onto the curved epis. Thus by moving slightly forward or back the direction of fire can be changed. At noted distances along these epis stakes are driven, thus enabling the gun to be brought up and stopped with the muzzle pointing in the desired direction without loss of time. Since the co-ordinates of the stakes and target are known the range can be computed before the guns are in the locality.

The relative position and elevation of the target, aiming point and guns having been ascertained the *orientation* problem is completed.

From comparatively simple methods with lighter guns to very complex computations with heavier pieces the data to be sent to the guns is now computed. As an illustration of the simpler method let us consider the problem where the guns are defiladed by a hill. The battery commander selects a point for his observation, let us say to the right of the guns, where he is able to see both target and aiming point. The men at the guns are not able to see the target but can sight on the aiming point. Therefore if the angle between gun-target line and the gun-aiming point line can be computed the guns can be directed on the target. By constructing imaginary lines parallel respeactively to gun-target and gun-aiming point lines at his observation point the battery commander can obtain this angle by the method of offsets. This result is telephoned to the directing gun of the battery, the remaining guns obtaining the correct direction from this directing piece after correcting for parallax or *gun-difference.*

The real skill and knowledge of the artilleryman are needed most when the actual firing of the guns takes place. He must have a clear understanding of the theory of probability and errors in order to adjust fire intelligently.

The gunnery problem now presents itself. There are two parts. First the center of impact of the battery must be placed on the center of the target in the shortest possible time with the minimum expenditure of ammunition. This requires a knowledge of the calculation of firing data and the principles of fire adjustment. Range tables have been tabulated for each type of gun, powder charge, kind of ammunition, fuse and

range. Thus knowing the range the battery commander may obtain the angle of elevation necessary. The use and construction of these range tables must be as familiar to the trained artilleryman as Ohm's law is to the electrician. Fire is usually adjusted by the battery commander observing the "overs" and "shorts" as the shells burst and correcting the range by the necessary amount to make direct hits. Still other and highly technical methods of adjustment are by sound and high burst ranging.

The second part of this gunnery problem lies in having well-trained men at the guns who will respond quickly and efficiently to the commands as they are telephoned to them from their Captain.

Secondly. let us consider the electrical engineer. Wireless outfits and telephone systems must be fully understood by the artilleryman. The battery commander controls his fire by telephone communication direct to his guns. All the firing data is given to the men at the guns in this manner. Although the signal-corps attends to all the telephone lines and communications between the different branches of the army the artillery must have their own details whose work it is to lay the lines and operate the systems.

If aerial observation is used the wireless plays an important part in the communication system.

The chemical engineer's side of the artillery game is a vital one. Size and kind of powder, the chemical composition of the primers, high explosives and gases must be known to the artilleryman. He must know their chemical effects in order that he may select the proper ammunition for the mission in hand. He must know their chemical properties that he may intelligently care for and store the ammunition to avoid deterioration.

Tractors are now generally used with the heavier guns. Their care and repair need a mechanical engineer, as also does the repair of the numerous trucks, motorcycles and other materiél.

The modern artillery officer must be an engineer, skilled primarily in the principles of civil and also those of mechanical and electrical engineering, as well as having the general culture common to all arms of the service.

ALUMNI

Ray Stanton and George Anderson, '14, who specialized in Electrical and Chemical Engineering, respectively, while in college, are now associated with A. C. Wood, Consulting Engineer, 1203 Stock Exchange Building, Philadelphia, Pa.

Ted Leopold, '15, after a sojourn in the Middle West, is located in Philadelphia, Pa. He has recently organized the Hardware Manufacturing Corporation, making ship and car hardware.

Robert B. Ferguson, '15, has an important position with Cramp's Shipyards. Ferguson was an intercollegiate champion hurdler in his Senior Year.

Louis De Carlo, '18, has been transferred from the Chemical Laboratory of the Bureau of Internal Revenue at Washington, D.C., to the branch Laboratory in Chicago, Ill. His address there is 1601 Transportation Building, 608 South Dearborn Street.

Arthur Williams, '20 C.E., is connected with the Bureau of Standards in Washington, D. C. He is experimenting with the possibilities of Gypsum in commercial lines.

Alexander Wray, Jr., '20 M. E., is in the standardization division of the Curtis Publishing Company.

H. Nedwill Ramsey, '20 M.E., is an Engineer with the American Gas Company. Mr. Ramsey was one of the leading undergraduates in Mask and Wig activities during his College days.

Robert W. Mayer, '20 Ch. E., is in the Sales Department of the Brown Instrument Company.

Francis Tatnall, '20 M.E., is an Engineer in the Kansas City branch of the Foamite Firefoam Company. His address is, 1012 Baltimore Avenue, Kansas City, Missouri. He was a member of the Hexagon Senior Society.

Herbert E. Calves, '20 M.E., is in the Sales Department of William F. Reed and Sons, of this city. He was a member of *The Pennsylvanian* Board and Managing Editor of the Class Record while in College.

Thomas H. Latta, '20 C.E., is an Engineer with Armstrong and Latta Company, Philadelphia, Pa.

William N. Russell, '20 C.E., is with the firm of Paul and Russell, Manufacturers and Contractors. He was a member of the soccer team and active in Engineering School affairs while in College.

T. Malcolm Williams, '20 M.E., is now a salesman with Francis H. Liggett and Company, New York City. His home is at 210 Holmes Avenue, Altoona, Pa.

Ernest H. Chapin, '20, is a Sales Engineer with the Wheeler Condenser and Engineering Company. His home is at Carteret, N. J. While in College he was a member of the Musical Clubs.

Horace Clinton Fehr, '21, is connected with the Bell Telephone Engineering Department in Philadelphia.

S. H. Ouerbacher and F. A Hall, '14, are selling Industrial Heating Devices Their office is at 303 Franklin Trust Building, Philadelphia, Pa.

Ezra Garforth, '14, is employed by David Lupton's Sons, Philadelphia, Pa. During the War Mr. Garforth saw active service in France as a First Lieutenant.

W. G. Mayberry, '13, is with the Electric Storage Battery Company, Philadelphia, Pa.

N. E. Eberly, '13, is with the S. S. White Dental Company of Philadelphia, Pa.

F. R. Palmer, '15, is a Metallurgist for the Carpenter Steel Company, of Reading, Pa.

NIAGARA FALLS POWER DEVELOPMENT

(*Continued from page 20*)

is equipped with an automatic governor controlling the valve in the penstock. A unique feature of this power plant is the fact that each generator has a complete control board beside it, from which it may be controlled as well as from the central control room. An individual transformer is provided for each machine with a secondary potential of 110,000 volts with taps provided for raising this to 132,000 volts if desired. The tops of the generators are level with the floor of the generator room. Repairs to the generators are facilitated by a traveling crane running the entire length of the generator room. Provisions have been made for repairing the turbines without disturbing the generators.

The Queenston-Chippawa development utilizes almost 100 feet more head than any other plant at Niagara, for which reason it will get 50 per cent more energy per unit of water. This plant with its 500,000 horse power capacity, brings the total power obtained from Niagara to 1,287,500 horse power.

ENGINEERING ADVERTISING

(*Continued from page 19*)

appear. The mechanics of printing are interesting, but there is no space here to go into the subject. Suffice it to say that your ad on pumps is finally printed and appears in the Advertising Section of the paper.

Now sometimes you have a wrong idea of what that ad should do. You know your pump is good—and you expect one ad—or a small series of ads to bring a flood of inquiries for catalogs, prices and orders This is rarely the case. What the ad really does is to make the way easier for the sale of your pumps by creating a favorable impression in the minds of pump users in the industries reached by that particular paper. *You cannot judge the value of advertising by the number of inquiries received.*

Of course there is a whole lot more to technical advertising than this. All this article could do was hit the very high spots! But there is a very attractive field for the man who can make good in technical advertising. There is much room for improvement. It has been written by laymen, who could write good corn flake ads—but who thought a centrifugal was a washing machine. It has been written by many engineers who could not put their arguments into the form that would make a real sales appeal. It should always be written by men who can appreciate the technical side, but who have the sales instinct—who can put this sales feeling into the ad.

Technical advertising will grow more and more in importance. Today it is regarded by many as an unimportant branch. Chewing gum or motor cars with a general appeal seem much more important. But when business gets under way and people realize more about the millions and millions of dollars spent by technical executives *every day* on equipment and material, technical advertising will be appreciated. If advertising can make you buy B.V.D's—it can influence you just as effectively when Drum Dryers are the product. Moreover, a comparatively small percentage of the firms which could and should advertise to advantage are doing so.

For the engineer who has had enough practical experience to have built up a background— who knows his profession *practically* as well as *theoretically*, and who can put the advantages of a product into a real selling argument, there ought to be a real future in technical advertising. Without practical experience he would have a hard road to travel. With it and two vital necessities—ability to write and a liking for the work, technical advertising ought to prove an interesting and profitable line of work for him.

University of Pennsylvania

FOUNDED 1740

The Towne Scientific School

1875

COURSES IN

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CHEMICAL ENGINEERING
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MECHANICAL ENGINEERING

For general information relating to the Towne
Scientific School, address

JOHN FRAZER, DEAN

Engineering Building, University of Pennsylvania, Philadelphia, Pa.

For special information relating to individual courses
write as follows:

For the Courses in Chemistry and Chemical Engineering

PROF. WALTER T. TAGGART, Director,
John Harrison Laboratory of Chemistry, University of Pennsylvania

For the Course in Civil Engineering

PROF. MILO S. KETCHUM, Director
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For the Course in Mechanical Engineering

PROF. ROBERT H. FERNALD, Director
Engineering Building, University of Pennsylvania

For the Course in Electrical Engineering

PROF. HAROLD PENDER, Director
Engineering Building, University of Pennsylvania

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Finals

THE results of action taken by the Wharton School in abolishing final examinations will be awaited with hopeful interest by the students of Towne. After careful investigation by the Wharton faculty, it was decided that the present system of final examinations placed too great a premium on "cramming" and did not lead to consistent work on the part of the students.

Of course we are all supposed to be here to get the most out of the courses which we take, but the majority of us are quite willing to take the easiest way in getting through our work. To many of us the term consists of four months of idleness, broken into occasionally by a football game or a quiz, followed by a week or two of frantic study in which we try to cover the material on which the examination is to be based. And most of us find that a week of work is enough, for it is rarely that a man fails to make good in his final. In fact, many men are saved by the examinations who would be forced to repeat the course if they were graded on the basis of the work done during the term. It seems inconsistent with Engineering practice to call a man successful because he has built an occasional big bridge that has remained standing while his smaller structures have collapsed. As a matter of fact, in the outside world he would never be given the opportunity to design the big bridge.

The only excuse for final examinations is the fact that they lead to a review of the whole course and a collection of the essential facts. The same result could be accomplished by devoting the time given to finals to a summary of the work in the classroom, where the really important parts could be reviewed and the minor features omitted.

It is to be hoped that the action of the Wharton School faculty will lead to a similar movement for the entire University.

Our Stadium

AT ONE time the University gave Philadelphia the largest and most adequate athletic field in this country. Some twenty years have rolled by since then and we still have the same old field, while Harvard, Princeton, Yale and many colleges of the West and Middle West have stepped forward with more commodious amphitheatres until now, though retaining its historic greatness, Franklin Field no longer has the facilities required to stage big athletic carnivals. Now comes the announcement that definite steps have been taken to increase the seating capacity to 50,000. Those who have seen he Relay Carnivals, football games, or intercollegiate track and field meets will readily agree that a place of this size is needed, and those who have waited years to hear such an announcement will receive it with cheers. Speed 'er up, boys, it's a long-felt need.

Our Undergraduettes

WE OF the Engineering School have little to do with the women students of the University. Although they fill our halls and amuse us while we are taking our quizzes, we are not brought into direct contact with the co-eds in any of our classroom work. We merely note in passing that some of them are good, some of them are not so good and all of them are noisy. But at least we accept them as facts, which is a thing that many of our separated brethren of Wharton and College refuse to do.

We quote from an editorial in *The Pennsylvanian:* "Repugnant as the situation is to the woman student, she insists on becoming a part of an institution which is traditionally a male institution—" Some one might remark that Eden was traditionally a male institution until Eve was manufactured, but we never hear any editorials urging the abolition of women. Co-education is a fact, not a theory. Conditions for the women students may be changed in the future, but Pennsylvania will never again be exclusively a male institution.

The Pennsylvanian goes on to say: "Hundreds of men are turned away from the University each year because the student capacity is limited to fixed numbers. Yet these women persist in taking men's places against their own wishes." It seems that our daily contemporary is annoyed, not by the fact that some women are let in, but by the fact that some men are kept out. No statement is made that the University is harmed by the women students.

As a matter of fact, if those who are so unthinkingly opposed to co-education were to investigate the matter, they would find that the co-eds are probably better Pennsylvanians than the men whom they keep out. The women students of today are not the "grinds" that they are reputed to be. They are just as active on and off the campus as any similar group of male students. There is a greater proportion of the co-ed student body engaged in campus activities than of the male. The co-eds have the best interests of Pennsylvania more at heart than a large number of the other members of this "traditionally male institution". Their class organizations do something, which is more than can be said of some of our highly honored and more highly centralized groups of men students. Every co-ed is acquainted with every other co-ed, because by their system of sister classes they carry out in a thoroughly practical manner the tradition which exists among the men only as a matter of form—the initiation of the Freshmen into the spirit of Pennsylvania under the guidance of the upper classmen.

It seems much better, from an Engineering standpoint at least, to look upon co-education not as a temporary evil, but as a state of affairs that can, if properly handled, result in the continued advancement of Pennsylvania.

Football

THE Towne Scientific School appreciates the efforts of the members of the 1921 football squad during the past season. They have been more or less successful, that is for no one to decide, but their hard work has been evident to all. They fought a losing battle, the hardest kind to fight, and not one of them showed a sign of the white feather. Every man gave his best and nothing more can be expected. They played the game on the square, they were gentlemen, they were true sportsmen and, above all, they fought like true Pennsylvanians. We wish them good luck next year. Our thanks.

Power Plants

EMLEN C. HEIDELBAUGH, '22

(Illustrations: Courtesy of The Philadelphia Electric Company)

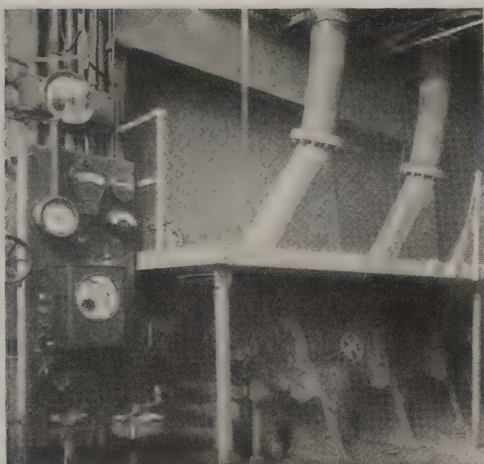

FIG. 1—SYSTEM OF COAL DISTRIBUTION

IT WOULD be impossible to go into the details of power-plant construction for two reasons. First, it requires years of training in mechanical and electrical lines and the writer—well, give him a chance. Second, space. The only remaining thing to do is to consider the factors which determine the final layout and location of plant.

The first thing to be considered is the location. Power plants are placed whenever possible on some stream or river, when it is near or at the center of the load. This provides for the delivery of coal in barges and the disposal of ashes in a like manner, at a cost considerably below the cost of the same coal delivered by rail. Any saving which can be made in fuel is a big item as it is about 85 per cent. of the station costs. By locating on a river or stream the condensers are always assured of a sufficient amount of cool water, which is necessary for the economical operation of any plant. However if the price of the water front real estate is excessive, it might be advisable to build at a distance from the river, running ducts underground for the carrying of water for the condensers, and either relying on the railroads for fuel supply or arrange to have it hauled from the barges. The Schuylkill Station of the Philadelphia Electric Company, shown on the frontispiece of this issue, is an excellent example of a station having condenser water ducts and hauling coal from the river with an electric locomotive.

The topography of the country influences the location. In one instance the plant was built on a small stream which ran at the foot of a cliff, the top of the Tracks were run from a railroad on the cliff to the roof of the plant, the coal cars dumping right into the coa bunkers above the boilers. This saved the handling of the coal.

In another place the center of the load was drawing nearer and nearer to a swampy piece of land on the water front. The local power company bought the swamp and built their plant on the edge of the river. They filled in the surrounding waste tract with their ashes, thereby creating valuable land.

Many of the larger power companies have commercial engineering departments whose duty it is to make studies of the past, present and future loads. The present load being known, the future is gauged by what has happened in the past, taken from company records. This gives the plant engineers the necessary data for determining the present equipment and the ultimate equipment for the plant under consideration. The architects and engineers work together in designing a building large enough o house the ultimate plant. The power plant of old was a cheap ugly building casting a gloom over the unfortunate community in which it happened to be. The modern plant on the other hand is a thing of architectural beauty, being superior to many of our public buildings. The exterior is not the final endeavor of the architect, for inside will be found tiled walls, efficient lighting and ventilating systems, rest rooms and, in fact, every modern convenience for the employee. This may seem like an extravagant expenditure of public funds, but it is good engineering and a sound investment. If the environment is pleasant the employee will turn out his best

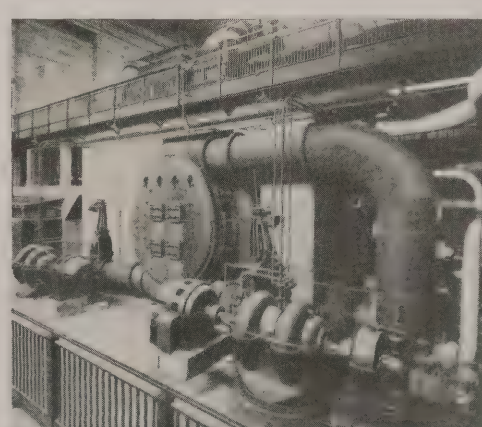

FIG. 2—TURBO GENERATORS

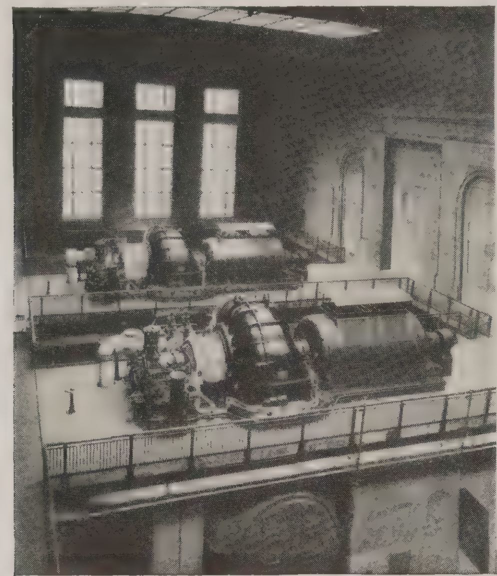

FIG. 3—GENERATORS

cliff being almost level with the roof of the plant. work, and the building will indicate a prosperous and progressive company, which is a very good advertisement.

The layout of power plants is entirely dependent on the conditions to be met. A very economical layout and one that has proven its worth is that of the Delaware Station of the P. E. Company.

Here the barges pull up to the pier and the coal is unloaded by means of coa' unloading towers provided with conveyor buckets. These bucke s carry the coal to the top of the plant above the proper coal bunker, where it is dumped by a bucket-tripping device. As the coal bunkers are directly above the boilers (these being located in the river side of the plant) the coal can be fired by gravity into the mechanical stokers by means of shutes, cutting down the extra handling of the coal and the soot and dust which accompanies this practice. The boiler room with this type of coal feed can be kept clean; some companies going so far as to put linoleum on the floors. Figure 1 shows this system of coal distribution and gives some idea of the cleanliness of this boiler room. The boilers are automatically controlled by the instrument board on the left. The energy in the coal is transferred to steam in the boilers, the steam then goes to the turbines in the adjacent room. The turbines are connected to the same shaft as the exciter and generator, thus avoiding any losses which might be introduced by some other method of energy trans'er.

Below the turbo-generators (Fig. 2) are located the condensers, water pumps, air-washing chambers and other auxiliaries, giving to the main floor of the turbine room a compact and uniform appearance. Figure 3 is a good example of a well-designed room with plenty of light, encouraging cleanliness and tidiness. It is also well ventilated with fresh washed air which is supplied through the generators to prevent them from overheating. The two turbo-generators shown have a total capacity of 60,000 K.W. In order to appreciate just what this figure means let us compare it to the work tha' one man can do. An ordinary laborer working eight hours a day can work at about one-tenth of a horsepower. It would then require 800,000 men, or about half the population of Philadelphia (if all were men) to generate what these two machines do.

From the generator the energy now in the form of electricity passes to the switching room and to the operating room or nerve center of the plant. These rooms are located on the shore side of the plant next

FIG. 4—OPERATING ROOMS

to but separate from the turbine room. The operating room controls the operation of the entire plant. Here increased loads are taken care of, preparations made for storms, and all trouble reported. Figure 4 is the operating room of the Delaware Station.

In a plant like this where service and continuity of service are essential the apparatus must be in duplicate and triplicate in cases of emergencies. There must be a flexibility of apparatus so that it will not be necessary to operate a large machine for a l'ght load. One way of getting around this is to "tie in" another plant's load in order to furnish a load for the large machine.

The problem of the power plant engineer is an interesting one, and one that offers great opportunities in the future.

Why, How and How Much

By Harold Pender, *Director of Electrical Engineering*

HAVE you ever asked yourself why you are studying engineering, and, having asked, given a convincing answer? I don't mean the sort of answer you might write to please your professor or even your father, but the kind of answer that really satisfies you and convinces you that you are doing the right thing.

What is engineering anyway? A terse definition which one frequently hears is that "engineering is getting the most out of a dollar". This definition is too broad, for it also applies to any kind of business, legitimate or otherwise. It does, however, emphasize one important aspect of engineering, namely, that engineering, whatever else it may be, is also a business proposition.

A less inclusive definition, and one which retains the truth embodied in that just given, is that "engineering is the application of physical science to the production of wealth." This leaves out the banker, the stock broker, the real estate dealer and the merchant, but includes the manufacturer and the farmer and every one else who utilizes the facts or principles of physical science in the production of wealth.

Now don't confuse the terms money and wealth. A man may make money and yet produce no wealth. On the other hand, he may produce wealth and yet as an individual make very little money. Ethically every producer of wealth is entitled to a money return in proportion to the wealth which he produces. However, we do not live in Utopia, but in a world where personality, tact and judgment of human nature often have far more to do with one's money-making ability than do the ethics of the case. Just keep this last fact in mind when you are considering engineering as a means of making a living.

If you have chosen engineering because you think it is an easy way of making a lot of money, I would strongly advise you to reconsider your choice. There are as excellent opportunities in engineering as in any other profession, but to reach eminence as an engineer requires the hardest kind of work. In order to apply the physical sciences to the production of wealth, one must first know these sciences. But knowing the scientific or technical side of his profession is merely the beginning. To apply his technical knowledge to the best advantage the engineer must also be familiar with modern economic and industrial conditions, must be able to determine what is worth producing, and how he may obtain the greatest return for what he produces. In short, with the possible exception of the research engineer, to make a marked success as an engineer one must be both a thorough scientist and an exceptional business man.

For the average man having a scientific turn of mind engineering offers a profession in which he will have congenial work and from which he can derive a fair income, but no more. But why should the average man expect more than an average return for what he does? If you want more than an average return, don't be an average man.

If you haven't a scientific turn of mind, don't try to become an engineer. By a scientific turn of mind is not meant that you must be a mathematical shark, but merely that you are interested in natural phenomena, their causes and effects and how they may be controlled for useful purposes. If such things bore you, then choose some other profession.

Let us assume then that you have a scientific turn of mind, that you are not afraid of hard work, and that you are convinced that engineering offers a reasonable opportunity for a successful career. The next question to ask yourself is, How can I best prepare myself to enter this profession?

Obviously, before one can apply the physical sciences to the production of wealth one must know the facts and principles of these sciences. It is to provide the opportunity for acquiring this knowledge with the minimum loss of time that technical schools have been established, usually in connection with the larger universities. Although there is such a thing as a self-made engineer, it is an accepted fact that the most effective way of preparing oneself for the profession of engineering is to take a course in such a school.

The first thing the student should realize when he enters a technical school is that the school cannot, and does not pretend to, make him an engineer. All the school does is to provide the opportunity for the student to *prepare himself* to become an engineer. It is entirely up to the student what he makes of this opportunity. Assuming the school to be properly organized, it is not what the teacher does but what the student does that counts. Teachers in a technical school are neither nurses nor taskmasters. A good teacher neither cajoles nor drives a student; he is there to tell what he knows of his subject and to help his students to acquire the knowledge they are seeking, not to apply either the nursing bottle or the lash.

As you read the last paragraph you undoubtedly said to yourself, "Well, what's the idea of marks then?" In my opinion marks have but a single purpose, namely, they are merely a convenient way of keeping a record of the extent to which the student is utilizing the opportunity offered him. Good marks of themselves are of no value to a student. It is the mental development which he has acquired in obtaining these marks that counts.

In this connection you may also ask, "Why, if it is entirely up to the student, should a student be dropped if his marks are low?" There are but two causes of low marks, loafing and mental incapacity. In any honest profession loafing cannot be tolerated, and the sooner the prospective engineer realizes this the better for him. If a student is actually incapable of doing the work assigned him, due either to inherent stupidity or lack of preliminary training, it is actually a kindness to him (although he may think otherwise) to prevent him from further wasting his time and effort.

The curriculum of an engineering school usually contains many subjects which, to the student, may seem at first to have no connection with engineering. Remember, however, that technical knowledge is only a part of the necessary equipment for success in engineering. An engineer has to deal not only with physical facts, but with human beings as well. Personal friendships count as much in engineering as in any other profession, and to form close friendships with big men one must have a liberal as well as a technical education. A knowledge of history, literature and the sciences not immediately related to one's profession may, if it has no other value, give you something to talk about when talking shop becomes wearisome.

There is another side to the four years of technical school training which the student should by no means neglect, namely, the opportunity which it gives him of associating with his own and other groups of students in all kinds of outside activities. It is in these associations that he will develop personality, tact and judgment of human nature, which ultimately play as important a part in the success of an engineer as his technical training. Nor should the student neglect, during these formative years, the opportunity of mingling with older people both on formal occasions and otherwise.

In this connection remember that personal appearance counts for much. Thank God, an engineer doesn't have to be handsome, and when he is working he can get as dirty as he pleases if his work demands it. But when he goes out with other people, or is doing office work, there is no excuse for slovenliness in person or in dress. To some people untidiness may not seem to matter, but untidiness has never helped a man to get a job or to hold one.

If you have followed me this far, it is about time for the question, "How can I go in for outside activities and do all the class work that is expected of me?" The answer is, "In just the same way that any professional or business man finds time outside his working hours for social activities and recreation." When a professional or business man is at work, he is not thinking about football, or the theatre, or even his best girl, but is concentrating on his work and is making every minute count. Can you say the same for the hours you spend on your books in preparing for the next day's lessons or in writing a laboratory report?

Don't think because you are sitting with the book in your hand that you are necessarily studying. In fact, you may even be reading the book and yet be wasting your time. Merely reading a description or a deduction is not sufficient to register the subject matter in your consciousness. You have got to use your brain as well as your eye. In other words, you have got to *think* as well as read.

Now don't confuse the words thinking and memorizing. A parrot can memorize, but I have never yet heard a parrot becoming an engineer (although some human parrots have tried to).

One way to make sure that you are thinking and not memorizing is to ask yourself continually the question "why?". Whenever you meet a new statement or deduction try to tie it up to what you already know. If there is any inconsistency between the two, then either this new statement is wrong or your earlier ideas are incorrect. Don't be satisfied until you find out exactly where the error lies.

Above all things, don't get into the habit of accepting as true everything that you see in a book, or even that your professor may tell you. Textbooks and professors don't lie intentionally, but they are not infallible. In particular, be shy of formulas which you cannot check. Solving a problem by substituting in a formula is not engineering, nor does it teach you anything. What really counts is to know when a formula is applicable, and what are its limitations.

Have you ever thought of a lead pencil as a thought stimulant? When properly used it is an enormous help in studying. If the matter in hand is the deduction of a formula, follow through the deduction, writing down not only the steps which are given in the book, but the steps which you yourself must supply in order that you may understand the deduction. If it is descriptive matter underscore the important sentences, or make a

(*Continued on page 30*)

Economic Advantages of Electric Traction

H. W. Wendt, '23

THE great economic advantages of electric traction over steam railways have been generally conceded for years. Although nearly all railroads have introduced it, in extents varying from a few miles to nearly a thousand, American roads have been unable to consistently favor the supplanting of steam by electric power because of difficulties in raising the necessary capital to make it possible. The electrification of main lines is no longer an experiment. The heaviest traffic can be handled, and there therefore remains only the question of whether the great initial cost will be justified by the savings accomplished. It has been the experience of all roads that the institution of electric traction shows a handsome return on the investment.

The paramount economy effected is that of fuel. The modern turbe-generator power plant is so economical as to use considerably less than half the coal now demanded by steam engines when effecting the same tonnage movement, even after including all losses of transmission and conversion of power necessary to reach the locomotive. The comparative fuel expenditure has been the subject of considerable investigation, and carefully compiled statistics indicate that it requires six pounds of coal on a steam locomotive to haul the same tonnage as could be handled with an electric locomotive by burning 2½ pounds of coal in an up-to-date power house. The ordinary steam locomotive evaporates 4 pounds of water per pound of coal consumed while a stationary plant evaporates 9 to 10 pounds of water per pound of coal. Furthermore, average locomotives deliver one horsepower to the tender drawhead for an expenditure of 30 pounds of steam, and the stationary plant can deliver the same power to the switchboard for 15 pounds of steam. If all the steam roads in this country were electrified, which will not occur at any time in the near future, the coal saving would be 100,000,000 tons per year. We should not forget that steam locomotives burn 27 per cent. of all the coal mined. While the amount of coal with which nature has blessed this country is enormous, it is by no means infinite. Estimates on the probable duration of our coal supply range from one to four thousand years, depending upon future consumption. Two thousand years is an average figure. The amount of coal we now burn yearly in steam locomotive fire boxes would produce approximately three times the useful power it now does if burned under stationary boilers and its energy transmitted to the motors of electric locomotives.

The first objection to electric traction which occurs to us is the loss in conducting current over large distances. But we should remember that the steam locomotive necessarily hauls its coal with it, and this involves a far greater waste of energy. Twelve per cent. of the entire ton-mileage movement of freight and passengers carried is represented in cars and tenders required to haul coal for locomotives. The electric world said some time ago: "Why continue to haul millions of tons of coal for and by uneconomical steam locomotives all over the country, and thus add more loads to the already overburdened railways, when the power which they need so badly can be much more economically and efficiently tran mitted to electric locomotives over a wire the size of one's little finger?"

Water power should, of course, not be neglected, but it is unevenly distributed and its possibilities seem likely to be overestimated. In mountainous parts of both East and West, doubtless large amounts of hydroelectric power could be developed. In this connection Mr. Beirce, Traction Engineer of the General Electric Company, has said: "It is a remarkable fact that ample water-power sources exist within easy transmission distance of practically all the great railways of the Northwestern United States and Canada. Many of these power sources are undeveloped, owing to the absence of a market for power and in some cases because of their location on government land. By the development of this water power, electricity could be delivered to the right of way of all the trans-mountain railways of the Northwest for a distance of one thousand miles from the Pacific coast." It seems unlikely that the above could be effected without destroying much of the scenic beauty of our National Parks.

The possibility of hauling heavier or even equal trains at higher speeds is becoming better recognized as a means of increasing tonnage over a given route and so provide for an increasing traffic more economically than by the construction of additional lines under steam operation. Steam locomotives of great weight on drivers capable of giving a tremendous drawbar pull are in general use, but such steam units deliver their maximum pull at very moderate speeds, and in conse-

quence their ton mileage per hour capacity is limited. In heavy hauling particularly the capacity of a single electric locomotive is ordinarily equal to three or four of the heaviest steam locomotives. On the N. & W. route electric locomotives haul heavier loads than three of the Mallet steam engines formerly used, and do this at twice the speed on the steepest grades and nearly four times the speed on other parts of the run. It seems that their power is limited only by the strength of the rigging of the cars.

Where mountain divisions are electrically operated a further saving is effected by regenerative braking. This is obtained by exciting the fields of the motors on down grades so that the counter electro-motive force builds up higher than the line voltage and returns power to the line, this action retarding the train to whatever extent desired without the use of air brakes, as well as supplying power to other trains on the line. The B. A. & P. R. R. has estimated a reduction of 18 per cent. in power due to regenerative braking. The C. M. & St. P. saved $200,000 per year in brake shoes while their line was still only 440 miles long. Although this in itself is not a great item, it represents a tremendous saving of energy. In addition it is unnecessary to stop to cool the shoes. Instructions for steam operation of a portion of the Denver & Rio Grande Railroad read "not to exceed eight to ten miles per hour and to stop every five and seven miles for from fifteen to thirty minutes." The economy of regenerative braking is evident in this case. In addition to the energy saving electric braking is conducive to greater comfort and safety. Air brakes are supplied as a reserve for emergencies.

There are, of course, other advantages to be derived from electric traction. Smoke and danger are eliminated in long tunnels. Smoky cities are made less smoky. For this advantage alone Chicago once considered electrification of all roads in the city, but, of course, found the cost out of all proportion to the benefit derived. Comfort of passengers is increased due to greater cleanliness. The electric locomotive is rugged and requires very little attention. Decrease in cost of engine repairs amounts to 33 per cent. on the Pennsylvania at New York. It is especially advantageous for roads having frequent stops. It is impossible for steam locomotives to accelerate as rapidly.

There are, of course, several disadvantages in electric traction. It is found to be expensive for light traffic railways, especially long trunk lines with intermittent service. On the Annapolis short line the cost per car mile was 28.5 cents with electric locomotives as against 23.1 cents with steam locomotives before electrification. The possibility of transmission difficulties during storms is always present, but the steam engine is also not immune to weather conditions. In very cold weather its efficiency drops, due to boiler radiation, while that of the electric locomotive rises.

The one immense disadvantage is the very high initial cost of installation and accompanying high fixed charges. Power plants and transmission lines are the big items. Electric locomotives cost twice as much as steam locomotives. It is well known that the close Federal supervision of railways has for many years prohibited extensive expansion. The only information at hand which includes fixed charges due to initial cost are those of the B. A. & P. R. R. This road, which was electrified in 1913 at a cost of $1,200,000, showed a total net saving per year over steam operation of $242,300 exceeding 20 per cent. upon the entire cost of electrification. In addition to this definite money saving the road secured a greatly increased capacity.

It would seem from a perusal of these figures that the steam locomotive is destined ere long to go the way of the horse car into oblivion, but it is extremely unlikely that it will ever go completely out of use. There are many long trunk lines on which electrification would be entirely uneconomical. But since the immense capital required to electrify has been the only prohibitive factor, we might reasonably suppose that within a period of fifty years this disadvantage will have been overcome. During the past decades of increasing costs electricity is one of the few commodities that has steadily decreased in price. Looking forward to the further developments which the future promises, and to the standardization of electrical equipment, the cost factor of electrification becomes less and less important.

Cork and Cork Insulation

G. Nelson Soeder, '23

CORK is the outer bark of the cork oak tree. The word cork is derived from the Latin *Cortex* (meaning bark). The cork oak is a peculiar tree. The acorns are rather small, but are used as food for the swine, giving the meat a most piquant flavor. The cork oak grows in the hot semi-arid parts of the Spanish Peninsula. The area, in which the tree flourishes, covers the whole of Portugal and extends eastward into Spain, covering thousands of acres. It is from these countries that the cork used in this country is imported. The cork oak is also found on the Northern Coast of Africa, but this region has not been developed to any extent. Just before the Civil War at-

tempts were made to introduce the cork oak into the United States, in the dry, hot climate of the Southwest; but these attempts were given up during the War and nothing has been done in recent years. The annual production of cork amounts to about fifty thousand tons.

The cork oak tree reaches at full growth a height of from twenty to sixty feet and measures in some cases four feet in diameter. Under government regulat ons, when it reaches a circumference of forty centimeters, which it does at the age of about twenty years, the "virgin cork", as the first stripping is called, is removed. This is of little commercial value due to its coarseness. The removal of this layer of the tree's bark does not injure the tree, but on the other hand tends to promote the growth of the inner bark, or real skin, which is of a much finer texture. As the tree continues to grow the real skin forms two layers, an inner one which increases the diameter of the tree, and an outer one which increases the thickness of the bark. After eight or ten years the bark is again removed, yielding a better grade than the virgin stripping, but not as good as the later yields. The str pping is repeated at intervals of eight or ten years. When the oak is about forty years old it begins to give its best grade of cork. In many cases the trees can be worked for a hundred years. although trees several hundred years old are ve y rare.

The stripping is usual y done in July and August. Great care is taken in order not to injure the tree in the removal of the strippings. This work is performed by natives. They use long-handled hatchets. The bark is cut clear around at the base and just below the branches. These cuts are then connected with one or two longitudinal incisions, and the bark is then pried off with the handle of the hatchet. The larger branches of the tree are also stripped. If in any way the inner skin of the oak is cut or scarred, a blotch will appear. This is a permanent injury greatly deteriorating the value of the cork of later strippings. The bark obtained is from a half to one inch in thickness. One tree yields from fifty to five hundred pounds of cork at each stripping depending on the age of the tree.

The cork bark is then sorted into the various commercial grades, packed into bales of about two hundred pounds each and shipped.

Cork is a very good heat insulator. This is readily explained from its growth and structure. The tree grows in a hot, dry climate. The bark is thus forced, as it were, by nature to protect the inner skin, containing most of the sap, from the hot rays of the sun. Thus in its natural state cork shows its insulating properties. If examined under the microscope cork is seen to be cellular in structure. Each of these cells in the cork contain a bit of air, and each one is air and water tight. The entrapped air forms the best insulator known, excepting a vacuum. The fact that they are air and water tight prevents the formation of any air currents in the cork which would tend to conduct heat from one part to another; and as water is a very good conductor its exclusion also increases the insulating property of the cork. In addition to all this, cork is relatively strong structurally; it is light and occupies little space; it is also very slow burning. Combining all these properties cork proves to be an ideal insulator. A very simple test, showing the waterproof property of cork, can be easily carried out. A piece of the cork is immersed in a beaker of water, weighing it down with some heavy weight. The water containing the cork is boiled for a considerable length of time. If the cork is then removed and broken in half, the inner parts of the cork will be dry. In the process of manufacture into corkboard and pipe covering none of these properties are lost, but they are improved.

The cork received in this country is ready for manufacture, the scale and other impurities having been removed before shipment. It is made into ordinary cork stoppers, washers, life preservers, and the like. Some is also made into linoleum and other floor coverings. The waste is converted into a by-product by using it in packing. Considerable of the cork is made into cork insulation.

In the manufacture of cork insulation the bark as it comes in bales from the ship is first broken. This is done in machines known as bark breakers. The bark breaker is essentially a rapidly revolving shaft which has sharp-edged projections along its length. The bark is crushed between these and a series of stationary projections attached to the side of the machine. The cork is then in small pieces. It is then blown by means of huge fans through a pipe to another machine known as a grinder. This machine is composed of a number of sharp knives which revolve and cut the cork into smaller pieces. The cork is then ready to be made into corkboard or pipe fittings.

That which is to be made into corkboard is put into a heating arrangement known as an expander. In this the cork is heated, the moisture driven off, along with most of the sap. This increases the amount of air space in the cork. The sap which remains acts as a natural binder for the cork. From the expander the cork is run into moulds slightly larger than the desired size of boarding. It is compressed in these moulds by means of a steam press. The moulds containing the cork are then baked in a long oven, which is arranged so as to be in continuous operation. The moulds enter

at one end and pass through the oven to the other end. Here the corkboard is removed from the moulds which can then be repacked and sent back through the oven. In the process of packing and baking the natural sap left in the cork binds the small pieces of cork together. This avoids the introduction of any artificial binder and the corkboard produced contains nothing but pure cork. The boards are then put through sizing machines where they are brought to the exact size desired and in addition are smoothed off. The boards measure 12x36 inches and from one to six inches in thickness. They are also made in different densities for various purposes.

The cork from the grinder is also made into pipe coverings and fittings. This is done in packing machines, where the cork is tightly packed into moulds of the desired size and shape. The moulds containing the cork are then baked in ovens where the sap again comes into play as a natural binder. The cork assumes the form of the mould, and after sufficient baking can be removed intact from the mould.

The larger pipe coverings are packed around a core which furnishes the hole for the pipe. The smaller sizes are packed solid and then split and the hole cut out. The fittings are made in two parts, which are joined together around the pipe joint.

The pipe coverings and fittings are usually further improved by covering with a layer of a mixture of rubber and asphalt. The rubber is melted and asphalt mixed with it; this mixture is then run onto the cork fittings.

This cork insulation is used for brine, ammonia, ice-water and cold-water lines; for covering brine coolers, ammonia accumulators, ice-water tanks, and filters, and the like. A refrigerating room lined with corkboard becomes very efficient, as ordinarily without any insulation most of the energy used in keeping the material in the room cool is expended in cooling the warm air which enters from the outside through the walls. With the use of cork insulation this loss is greatly reduced. The same may be said of feed lines, not only those of a refrigerating system but also of cold-water drinking systems on the large scale. The cork insulation is neat, serviceable and, because of its slow-burning property, practically fireproof.

Heavy density corkboard is also used as an absorber of the vibrations caused by fans, presses and motors. This greatly reduces the wear on a building due to the constant shock of a large machine in operation.

American Chemistry

A MESSAGE FROM DR. EDGAR FAHS SMITH, *Provost Emeritus*

YOU have asked me for a few lines on chemistry. Throughout the entire world, since the great War, chemistry and its possibilities have been freely discussed. There has been a general public awakening to the wonders of the science. Men and women are realizing that no science comes so closely to them, is so intimately connected with their every-day pursuits.

A burning question among chemists themselves, at present, is whether the industries which have arisen in recent years shall be perpetuated. Their hope is that the place now held by our industrial chemical plants shall be maintained. That this may be, it is absolutely essential that our Government shall protect and foster the projects now under way and those expecting to go forward. In a few plain words—chemical industries require protection. Unles this is granted them, they will soon fall away.

The position in the great industrial world held today by the United States will be lost. Research will be sadly crippled and our profession will fall far into the rear. What is essential at this hour is a deep and sincere patriotism. That will insure preservation and promulgation of all that is needed by our country. Many persons tremble at the proposed "Dye Embargo". They imagine it will lead to monopolies. There is no danger of this. Dye industries can be controlled. But the elimination of the dye industry will sadly affect all other work in chemistry. With these facts before us one readily understands that this year is critical for us as chemists. Let us hope for the best.

A pleasant incident of recent date was the presentation of a beautiful portrait of Dr. Joseph Priestley to the National Museum at Washington. This was the gift of the American Chemical Society.

American chemists are realizing the debt they owe to Priestley. Their gratitude has in part been expressed in this way. It is to be further augmented by a medal—the Priestley Medal—which it proposes shall be awarded every second year by the Society to any one who has rendered distinguished services to chemistry. The Medal will be of gold and recalls the Davy Medal, the Farday Medal and the Copley Medal awarded similarly by our English brothers.

Let each one do his share to advance a knowledge of chemistry among the general public.

A Machine Made Productive

L. N. Gulick, B.S. in M.E.

IT IS interesting to note how often devices are placed on the market for sale, which fall far short of giving the results which the buying public expects to obtain when making the purchase. This condition prevails in the case of goods procured from well-known and reliable concerns, as well as from less reputable ones.

Machines are often designed, built, and marketed, which, theoretically, have many new and highly desirable features, and which, from all appearances, should be able to command a high place in practice. But the fact that they are limited in the scope of work they perform, or that their upkeep is too great to warrant continued usage, or that the conditions met do not equal those which the designer assumed to exist, makes them next to useless.

The amazing part is that often in the case of machine tools, some insignificant item is poorly designed, because the inventor was too busily engaged in perfecting a major part. But the immediate result is that the device, which would ordinarily be a success, is constantly out of order. And it falls to the lot of some foreman or mechanic, the user, to put on the finishing touches, and often, as a result, the machine is made more useful than the builder had expected it to be.

The fundamental principle in the alteration of, or addition to, automatic machinery is not to change the construction so completely as to destroy the original identity. There is little satisfaction gained in modifying a lathe, for instance, so that it can no longer be called one. There is, though, considerable satisfaction in making a machine perform its duty in a better way than the builder ever dreamed was possible.

The particular case in question is that of a cold cutting-off saw, shown in its original form in Figure 1. The belt-driven pulley A drove the shaft B through two spur gears, and by means of a pair of helical gears, the circular saw C was caused to rotate. E is a rack, which made possible the rapid horizontal motion of the carriage which supported the saw, by the rotation of hand wheel F. The work-vice is plainly shown, and was operated by hand wheel G. The principle of weight feed was the one which made the machine a failure.

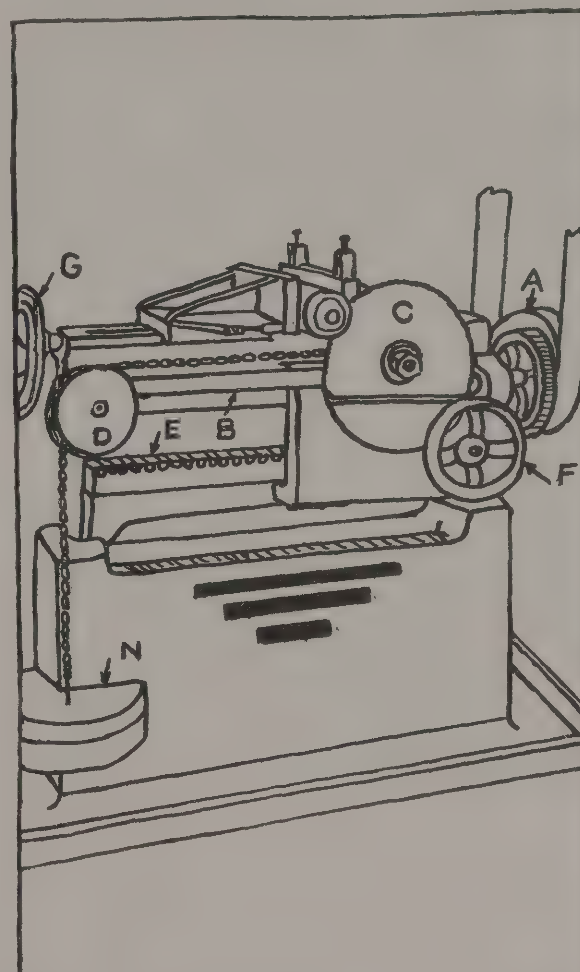

Fig. 1.

The weights are shown at N, and were connected to the saw carriage by a chain running over pulley D. The supporting boss for the pulley is plainly shown in Figure 2, as part of the bearing which supports shaft B. As the saw cut away material, the weights were designed to pull it on through the material. But, despite the fact that saws with fine, medium, and coarse teeth were tried, the saw chattered and bounced back and forth, due to the irregularities which are inherent in all kinds of metal. Sometimes in a few seconds a new saw would have several teeth broken out. No change in amount of weight at N, or quantity of material or character of the saw teeth seemed to make any difference.

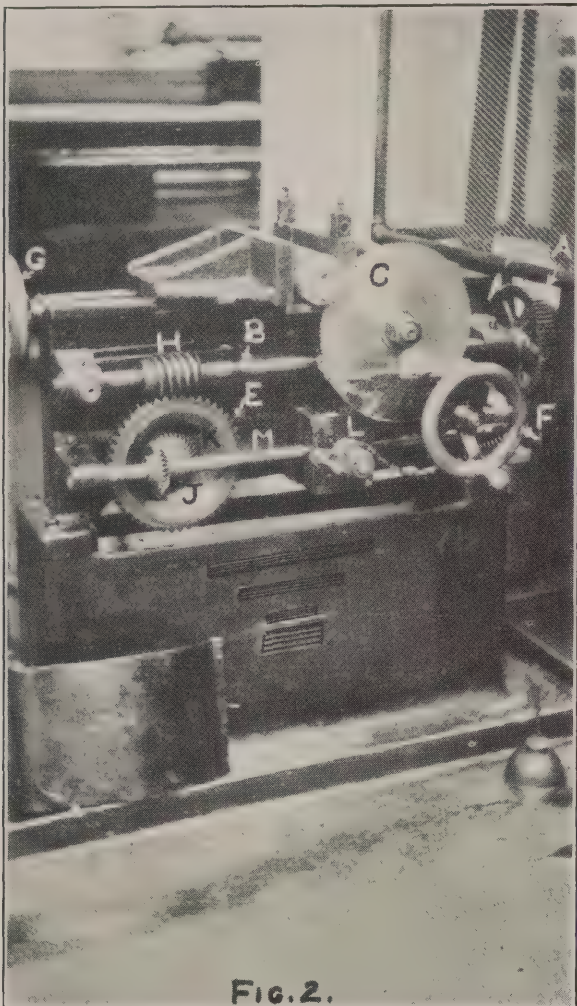

Fig. 2.

Thus was conceived the idea of providing for the saw carriage, a positive feed, as indicated in Figure 2. The drive of shaft B, and saw C are the same as previously described, but worm H is keyed to shaft B, and drives worm-wheel J. The latter, in turn, transmits power to shaft M through the bevels at K. The shaft M is supported by bearings at either end, one of which can be seen in the picture. A split nut L is fast to the saw carriage, and is operated similar to the nut used for screw cutting on a lathe carriage. With the nut open, the carriage can be moved rapidly by hand wheel F as before. The work vise remains unchanged. The chain fastened to L, and working with the spring shown back of F, forms an automatic throw-out, which prevents the split nut from jamming the worm-wheel.

In making the calculations, it seemed advisable to figure on an average feed applicable to all kinds of metal, and the gear-train was laid out accordingly. Continuous operation since alteration has shown that one-half inch feed per minute with a speed of 25 R. P. M. for the saw is very satisfactory. The saw diameter is ten inches.

The machine as it now stands is capable of cutting 6-inch round in two cuts and larger stock in more cuts. Thus it is seen, that with a small amount of machine work, and without destroying the original identity, a useless machine has been made productive.

Industrial Engineering

R. W. Chew, '22

THE science of engineering has grown during the last century from the work of a few constructors and designers of forts, docks, harbor improvements, military works, machinery, etc., to a multiplicity of special employments, until the engineering profession includes not only civil, mechanical, electrical and chemical engineers, but many other specialties to which have been given different names.

During this same period there has been a phenomenal growth of all industrial work. From the small shop with its single proprietor, this growth and tremendous development has resulted in the formation of large corporations with complex systems of organization. This industrial development has multiplied the problems of administration, and the science of organization and management has become a profession, which has been called "Industrial Engineering".

The industrial engineer should be a technical man with a general knowledge of the special class of engineering which is allied to the work of the company he is with, and he must also be versed in the science of management and organization.

Formerly only non-technical men with a purely business education were called upon to solve the problems of administration and management. But as the problems became more and more complex the value of the engineer in this field was recognized.

The successful engineer really is an economist. His function is not only to design, but also to design so as to insure the best economical result. The dollar is the

final term in almost every equation which arises in the practice of engineering in any or all of its branches. The engineer should determine not only how a problem should be solved, but how it may be solved most economically. It has been said that an engineer is a person who can do for one dollar what any darn fool can do for two dollars.

Let us investigate some of the problems confronting the industrial engineer. The relations between employers and workmen form without question the most important part of the art of management. What the workmen want from their employers beyond anything else is high wages, and what employers want from their workmen most of all is a low labor cost of manufacture.

The possibility of coupling high wages with a low labor cost rests mainly upon the enormous difference between the amount of work which an average man can do under favorable circumstances and the work which is actually done by the average man. But the proper incentive must be supplied, and just how this is to be done presents the main difficulty. It takes actual cash in the form of additional wages, bonuses, and improved working conditions to furnish this incentive, and if the cost of supplying the incentive is greater than the increase in profit due to the greater amount and better quality of work done, that plan is a failure.

The custom of paying a group of workers at a uniform standard rate of pay by the day is, as a rule, bad management. Under this plan the better men gradually but surely slow down their gait to that of the poorest and least efficient. When a naturally energetic man works for a few days beside a lazy one, the logic of the situation is unanswerable: "Why should I work hard when that lazy fellow gets the same pay that I do and does only half as much work?"

Co-operation, or some form of profit-sharing, has entered the mind of every student of the subject as one of the possible and most attractive solutions of the problem. Although there have been some successes, co-operative experiments have generally failed. According to Frederick W. Taylor—a foremost authority on industrial engineering and shop management—profit sharing is a failure for several reasons. In the first place, each man is not given a separate and distinct reward. The few misplaced individuals who do the loafing and yet share equally in the profits with the rest, under co-operation are sure to drag the better men down toward their level. A second reason for failure lies in the remoteness of the reward. The nice time they are sure to have today, if they take things easy, appeals more to the average mind than hard work with a possible reward to be shared with others six months later. Other difficulties in the path of co-operation are the equitable distribution of the profits, and the fact that while workmen are always ready to share the profits, they are neither able nor willing to share the losses.

Piece work is thought by many to offer a satisfactory solution of the problems of management. But it must be remembered that on plain piece work the less competent workmen will always bring what influence and pressure they can to cause the best men to slow down towards their level. Moreover, under the ordinary piece-work system, there is generally a feeling of antagonism between the men and their employers. The worker feels that if he works very hard and increases his output very much, the price per piece of the work he is doing will be lowered.

Mr. Frederick Taylor, in his book entitled "Shop Management", enumerates four principles which properly applied, he believes will successfully solve the problems of industrial management. They are as follows:

1. A large daily task—each man in the establishment, high or low, should have a clearly defined task laid out before him. This necessitates a planning department to schedule and assign tasks.
2. Standard conditions—the work should be carried out under such standard conditions, and the workman should be given such standard appliances, as will enable him to accomplish his task with certainty.
3. High pay for success—he should be sure of large pay when he accomplishes his task.
4. Loss in case of failure—when he fails he should be sure sooner or later that he will be the loser by it.

There is nothing new or startling about any of these principles, and yet they are daily violated over and over again in most shops. In establishments where they have been strictly adhered to, they have been accompanied with great success. Under these principles, day work, straight piece work, piece work with a bonus, and various other schemes, all have their especial field of usefulness.

Industrial engineering is yet in its infancy. At the present time very few universities or colleges present an industrial engineering course. The broad field of industrial engineering lies open to the mechanical, electrical, civil, and chemical engineer. It presents great possibilities. A competent industrial engineer has the qualifications of a successful executive, and industrial engineering may well be the stepping stone to something greater. Ten years ago executives who were engineers were comparatively few and far between. Today they are fairly common. Ten years from now they will, perhaps, be the rule.

And the Smoke Went up the Chimney Just the Same

William B. Campbell, '22

(Illustrations courtesy of the H.S.B.W.-Cochrane Corporation, Philadelphia)

SOME folks consider the smoke from tobacco (and from cigarettes and other substitutes for tobacco) to be a nuisance, but every one recognizes chimney smoke to be a nuisance. It soils the clothes on the clothes-line and on our backs. (Remember Phoebe Snow who chose the Road of Anthracite for its cleanliness?) It grimes up our buildings, irritates our nostrils and throats, and interferes with all kinds of manufacturing processes. Its prevention however, is not merely a matter of passing ordinances and appointing inspectors. There is a story of a political heeler who was given the job of smoke inspector as a sinecure, with a reminder that he must turn in a report each month. His first one read: "I have the honor to report that I have inspected the smoke in the town of Osmosis, and find it to be of fair quantity and consistently good in quality." But even a conscientious inspector cannot cure by simply jumping on the offender; he must have a knowledge of how to prevent smoke, and must cooperate with the owners so that they may learn how to make the necessary changes and save themselves money.

Smoke in general represents incomplete combustion. It consists of tiny particles of carbon or tar suspended in the flue gas. These particles when glowing in the furnace give the fiery appearance to the flame, but if the gases are cooled below say 2500° F. before the particles get a chance to be burned, they pass up the chimney. Even with dense smoke, the solid material thus lost is not over one per cent. of the carbon supplied in the coal, but the same conditions which allow it to escape permit unburned CO and combustible hydrocarbons to pass off, resulting in three to ten per cent. losses, so that visible smoke acts as a sort of telltale.

Methods of prevention for smoke include the furnishing of sufficient air for combustion, better mixing of the air with the gases, and the building of larger combustion spaces, so that the gases coming off the grates have time to burn before they strike the boiler tubes, which are comparatively cold, say 300 or 400° F. Figure 1 shows a style of setting designed by Osborn Monnett for the Chicago Department of Smoke Inspectors, for use with ordinary horizontal return tubular boilers (the type in which the water and steam are contained in a cylindrical shell, pierced by tubes through which the hot gases flow). The coal is fired onto the grate (to the right, about half-way below the boiler shell), the gases rising therefrom pass backward, are split into two parts by a double arch, and go through the two hot retorts over the bridge wall, then under the low single-span deflection arch to the back of the boiler, whence they return through the tubes and pass up to the chimney from the front. Figure 2 shows a water-tube boiler, in which the water lies in the sloping tubes and the horizontal drum above, with steam in the upper part of the drum. This furnace was fired by a chain grate shown at the left at the floor level, consisting of a slowly moving jointed web which carries the burning fuel into the furnace, turns on pulleys and returns empty underneath. In the condition shown in Figure 2, tiles mounted among the tubes served to baffle the gases vertically, so that coming off the grate they ascended and came in contact with the front portions of the tubes (to the left) then descended over the middle third and rose again and passed out through the rear opening under the drum. This arrangement made more or less smoke. It was corrected as shown in Figure 3. The boiler was raised two feet, a brick ignition arch to keep the gases hot was inserted over the grate, and the baffling was changed so that the gases shot back and forth horizontally in several passes through the tubes. Figure 4 shows a "down draft" boiler used for small installations. The coal is fired onto the upper grate, which consists of water pipes, connected to the boiler, and the distilled gases are sucked

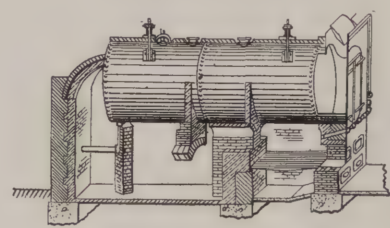

Fig. 1

Fire-Tube Boiler for Smokeless Combustion

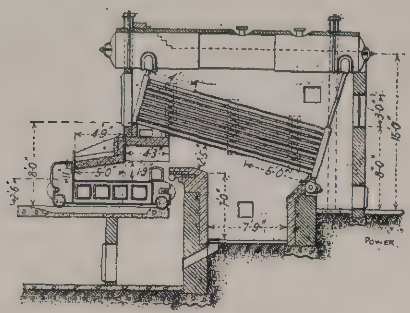

FIG. 2

WATER-TUBE BOILER WITH VERTICAL BAFFLES

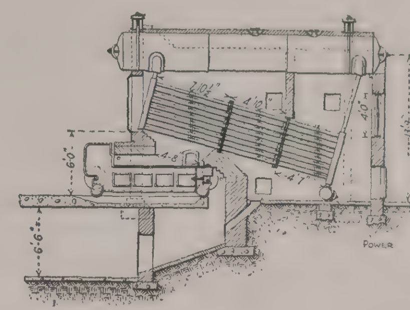

FIG. 3

SAME, REBAFFLED AND RAISED WITH IMPROVED FURNACE

down through the incandescent fuel, and intimately mixed with the heated air coming up through the lower grate, which receives the hot coke falling from the upper grate. The gases then pass out through tubes in the back part of the boiler.

A plant which *never* produces any smoke is probably using too much air, which means a large loss of heat in the extra amount of flue gases produced, and it is generally recognized that a plant should be permitted to produce smoke temporarily when carrying a heavy load, say for six minutes in an hour. The blackness

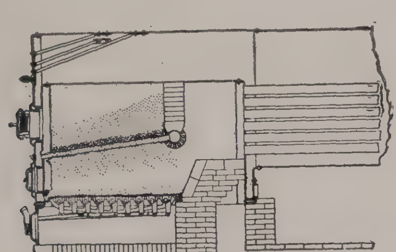

FIG. 4

DOWN DRAFT FURNACE SMOKELESS COMBUSTION

of smoke is judged by Ringelmann charts, a sample of which appears in Figure 5. Charts like these (covering a larger surface with the same size ruling) are placed fifty feet from the observer and he records the number which approaches most closely to the grayness of the smoke coming out of the chimney. Such a system, however, shows color only, and the column of smoke issuing from a large chimney may be so thick through that it looks darker than that from a small stack which really carries more soot per pound of coal burned. It has been suggested that a telescope be used with a series of half-lenses colored to represent the permissible darkness of smoke from chimneys of various sizes. A recording arrangement has also been used in which a selenium disk carrying current was exposed to light coming through smoke, and the grayness judged by the

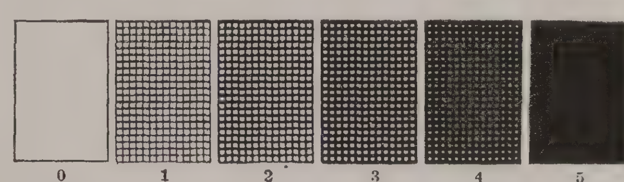

FIG. 5

RINGELMANN SCALE FOR GRADING SMOKE DENSITY

variations of the conductivity of the metal with the amount of illumination on it. Of the making of power-plant recording devices there is no end, but the greatest offenders in the smoke question are small plants which cannot afford these refinements. However, an efficient municipal smoke inspection department can suggest changes and train the firemen in the methods to keep up efficiency.

*The Production and Use of Asphaltic Products for Roads

Prevost Hubbard, *Chemical Engineer, The Asphalt Association*

Origin and Formation of Asphalt

ASPHALT is the oldest waterproof adhesive known to man. It invariably originates in petroleum, whether produced by natural agencies or at a petroleum refinery. In simple language it may be defined as a semi-solid or solid sticky product formed by partial evaporation or distillation of certain petroleums. Petroleum which yields asphalt by these simple processes is known as asphaltic petroleum and actually carries the asphalt dissolved in relatively volatile oils. When these oils are removed by evaporation or distillation the asphalt is left.

Asphalt formed at or below the earth's surface by natural processes of evaporation or distillation is commonly termed native asphalt. If produced in a still at a refinery the term petroleum asphalt is sometimes used to describe it. There is no essential difference between native asphalt and petroleum asphalt except that the former has usually become mixed with mineral or vegetable matter while the latter is practically 100 per cent. pure asphalt.

Pure asphalt belongs to a class of materials known as bitumens, which dissolve completely in the chemical known as carbon disulphide. Ordinary vegetable and mineral matter do not dissolve in carbon disulphide. If mixed with asphalt they can therefore be separated by treating the mixture with carbon disulphide and filtering off the dissolved asphalt. This method is used to determine the percentage of asphalt present.

Asphalt formed within the earth sometimes seeps to the surface through fissures in the overlying rock formation and collects in natural depressions. Seepages of asphaltic petroleum may also collect in a similar manner and through loss by evaporation gradually harden to asphalt. Thus an asphalt spring or asphalt lake is formed depending upon the size of the deposit.

In certain cases porous rock formations impregnated with asphalt are exposed by erosion and any resulting seepage seldom has an opportunity to collect in paying quantities. The rock, usually a sandstone or limestone, permeated with asphalt is known as rock asphalt. Under favorable conditions such material is quarried and crushed after which it is softened by heat and laid as a paving material in much the same manner as artificial mixtures of asphalt and mineral matter.

In certain instances, seepages of asphalt collect in large veins or faults in the rock structure and here, under the action of heat, become hard and brittle. Such products are mined in the same manner as coal. They are usually of little interest in the paving industry but are utilized mainly in the manufacture of asphalt products for various other purposes.

Early Use of Asphalt

Asphalt was probably first discovered by the Ancients, occurring as springs or pools. It was first used as a cement or glue and relics of early civilization, dating back to the year 3000 B. C., have been found in the Euphrates valley, showing such use. When mixed with earth or clay it was also used for moulding purposes and as a mortar for brick construction. History first records its use as a paving material about 700 B. C. when King Nabopolassar of Babylon constructed a brick pavement in which the brick were cemented together with asphalt.

Except in the form of rock asphalt which was laid as a paving material as early as 1802, the use of asphalt for this purpose was not extensively developed until the latter part of the nineteenth century.

About this time a large lake deposit of asphalt on the Island of Trinidad, lying just off the coast of Venezuela, began to be commercially exploited. This asphalt lake covers an area of about 127 acres and is over 150 feet deep at the center. The crude Trinidad asphalt consists of a mixture of asphalt with large quantities of finely divided clay, vegetable matter, gas and water. The upper crust is sufficiently solid to bear the weight of man and beast and is broken up with picks and loaded into carts which carry it to the docks for shipment to the refinery.

The only other lake deposit of interest in highway work is known as Bermudez Lake and occurs in Venezuela. Bermudez asphalt is softer than Trinidad and is mixed with less extraneous matter.

Refining Lake Asphalt

Crude lake asphalt must invariably be refined before it is suitable for use in highway construction. The refining process is conducted in large metal tanks heated by means of steam coils and equipped with perforated pipes through which air or steam is forced for the purpose of agitation so as to prevent local overheating and consequent injury of the asphalt. The chunks of crude asphalt are thrown into the tank and melted. The

* Paper presented at the "Highway Engineering Conference," University of Pennsylvania, February 10, 1921.

temperature is then gradually raised until all water and light oils are evaporated. Vegetable matter floats to the surface and is skimmed off while the coarser particles of mineral matter settle at the bottom. The refined asphalt may then be drawn off and barreled. It is invariably too hard for direct use and must be softened to suitable consistency by mixing it with a fluid petroleum product known as flux oil.

The fluxing process is sometimes conducted in the original tank after the crude asphalt has been refined. It consists merely in agitating the asphalt with the proper amount of flux oil until a homogeneous product of the desired consistency is produced. When the fluxing process is not carried out at the refinery the refined asphalt must be fluxed at the paving plant before it is mixed with the other constituents of the pavement. Refined asphalt, too hard for direct use is commonly termed R. A. When fluxed to suitable consistency it is known as asphalt cement and often called A. C.

Recovering Asphalt From Petroleum

Asphalt is refined from crude asphaltic petroleum in 50,000-gallon cylindrical iron stills, set horizontally and heated from below. Inside they are equipped with perforated pipes through which steam is forced during refining. The process is very simple and quite similar to that described for lake asphalt except that, because the volatile products have considerable commercial value, they are carried off from the top of the still through a vapor line and condensed in water-cooled oils.

The temperature of the oil in the still is never allowed to exceed 600 or 700° F. and this coupled with steam agitation prevents injury to the asphalt left behind. As distillation progresses the material remaining in the still becomes more and more viscous until finally a semi-solid or solid residue is produced. Distillation is stopped when the asphalt has reached the desired consistency. No fluxing is therefore necessary.

In the manufacture of asphalt fillers for brick pavements it is customary to blow air through the melted asphalt at a certain stage in the refining process. This produces a higher melting point asphalt than would be produced by straight steam distillation.

Except for water which is removed by distillation, petroleum is practically pure bitumen. It therefore follows that petroleum asphalt is pure bitumen, and its use does not have to take into account the presence of vegetable and mineral matter.

Asphalt Types of Construction

Asphalt is used in the construction of four distinct types of asphalt pavement: asphalt macadam, asphaltic concrete, sheet asphalt and asphalt block.

The asphalt macadam consists of a course of broken stone to which melted asphalt is applied so as to coat and penetrate the entire course. Stone chips are then spread to fill the surface voids and followed with a seal coat of hot asphalt and stone chips.

Asphaltic concrete consists of an intimate mixture of asphalt, broken stone or gravel, sand and mineral dust laid and compacted hot usually in a single course. A seal coat is sometimes used to finish off the surface.

Sheet asphalt is constructed in two courses. The lower, an asphaltic concrete, is known as binder course. The top course is composed of a mixture of asphalt with carefully graded sand and mineral filler.

Asphalt blocks are composed of asphaltic concrete, molded under great pressure. The blocks are laid upon a sand or mortar cushion in the same manner as brick.

As a filler for brick pavements hot asphalt is ordinarily squeeged over the surface of the brick, after they have been laid, so as to fill the spaces between the brick. For stone block pavements it is customary to use a grout composed of a mixture of equal parts of hot sand and asphalt.

For expansion joints for monolithic pavements asphalt is often premolded in strips to be inserted in the joint slots.

Consistency of Asphalt

For every type of construction in which asphalt is used it is of the utmost importance that the asphalt cement be of proper consistency. Consistency is determined by means of a penetration machine which records the distance that a standard needle will penetrate a sample of the asphalt.

The test is ordinarily made by bringing the needle under a load of 100 grams in contact with the surface of the asphalt, maintained at 77° F. and noting the distance that it penetrates during a period of five seconds. If the needle penetrates 50 units the asphalt is said to have a penetration of 50. It is evident that by this test the harder the asphalt the lower is its penetration. While there are a number of other tests for asphalt the penetration test is the most important and in refining is used as a control of consistency. This test is almost invariably included in asphalt specifications.

For the four main types of asphalt pavements which have been briefly described the following table shows the proper limits of penetration of the asphalt cement. It will be noted that for each type the controlling factors are traffic and climatic conditions. The lowest penetration asphalt, or in other words the hardest, is

(Continued on page 24)

TOWNE TOPICS

THE A. I. E. E.

A meeting of the A. I. E. E. was held in Room 313 of the Engineering Building, Thursday evening, November 10th. Chairman Heidelbaugh opened the meeting at eight-thirty o'clock. The minutes of the last meeting were omitted, but the treasurer's report was read. Suggestions were asked for in regard to having some form of entertainment provided at the meetings. An appeal was made for all freshmen and sophomores to get behind the club and insure its success. The first speaker of the evening was Mr. C. W. Plass, of the Bell Telephone Company, who spoke about success and the factors which lead up to it. He especially urged the members to become better acquainted with each other. Following the suggestion of Mr. Plass, Chairman Heidelbaugh requested every one to stand up in turn and give their names and tell who they are and what they are doing. Dr. Pender and Mr. Keiser, of the Electrical Engineering Department, were not excused, and both made short speeches. After this, refreshments were served and the meeting was closed by singing a Penn song.

PRIESTLEY CLUB

Following its policy of obtaining speakers of only a semi-technical nature, the club heard an extremely interesting talk by Mr. James, a Cornell graduate, on November 16th. "Early Experiences in the War Zone" was the subject. Mr. James was an English lieutenant during the earliest days, and was on the front when the first gas attack was made. He particularly emphasized the fact that the British were aware that the gas attack was about to be used.

Dr. Fernald has arranged to talk on "The Young Man in Industry" in the near future.

LECTURE TO CHEMISTS

On Monday afternoon, November 28th, and again on Tuesday, Dr. Ernst Cohen of the University of Utrecht, Holland, talked in the chemistry laboratory lecture room of the "Metastability of Matter and Its Relation to Chemistry and Physics." There was a large attendance of faculty and students, many crowned heads of the Physics Department being among the notables present.

Professors from nearby institutions were seen as well as chemists and physicists from large industrial plants.

Dr. Cohen is vant Hoff Professor of Physical Chemistry at Utrecht, and is one of the most prominent of Continental scientists. His work on the Standard Wes on Cell and his researches into the physical properties of matter and the allotropic forms of mat'er are particularly notable. He came to this country in September as official representative of Holland at the American Chemical Society Meeting and is remaining a few months, lecturing on his favorite subject.

DR. SMITH HONORED

Dr. E. F. Smith, our former Provost, has been appointed Technical Adviser of the International Disarmament Conference, now in session at Washington.

MEN ABOUT TOWNE

As the Engineering School knows, or should know, a society called The "Men About Towne Club" was formed in 1919, the members of which were selected from the cast of the show of that year.

William Marshall, M.E. '21, was the first President, and under his leadership and general good management, the club's finances and reputation prospered so that today both are on a firm footing.

The purpose of the club is the production of the annual Engineers' Show. This year's production is called "All For Love, or The Plumber's Bride", a musical comedy in a prologue and two acts. This spasm of combined humor and melody was thrown together by Charley Simon, Ch.E. '22 (the present President of the club and the show's author) in collaboration

with Robbie Robinson, Ch.E. '23, Stan Hubbard, Wh. '23, and Charley MacAnally, M.E. '22, who have written the music; Eddie Burke, C.E. '22, who has written the words to this music; Bill Marshall, M.E. '21, who has coached the dancing; Pat Patterson, M.E. '22, who has taken charge of the general construction, and Ray Spiller, M.E. '22, who leads the orchestra.

The Prologue touches the spot when it says:

"Our play has nothing to do with its name.
There's not very much love, and no Plumber's bride,
So we'll show Mr. Shubert and others of fame
We're ahead of their game,
Yes, ahead of their game."

From the outset, the play is "foolishness all undiluted, guaranteed".

The cast, chorus and orchestra are uniformly good, those outstanding in their excellence being Kessler, Ch.E. '22, and Schlein, C.E. '22, "Benson and Hedges" and the Prologians, the Captain and the Crew, Bill Lipp, Ch.E. '23, and Johnny Carter, M.E. '22. However, the mention of individual names is foolish, for those who see the show will judge for themselves, and those who do not see it will not know what they've missed.

Under the coaching of Charley Simon the cast rounds nicely into shape, and to Bill Marshall we hand the credit for one of the best dancing choruses in years. Too much thanks cannot be given to Bill for the generous way in which he gave us his services.

As to the general impression the show gives, modesty forbids our speaking of it in the glowing terms usually used in describing a production of such unsurpassed lavishness, splendid to the last finished detail, which is combined with a rollicking humor and a musical program that contains real melody.

We state again—modesty forbids.

ENGINEERING ASSOCIATION

The first gathering of the year of the Engineering Association was held at the Houston Club on the night of December 2d. The Association was entertained with an illustrated lecture by Mr. A. A. Northrup. Mr. Northrup is a representative of the Stone & Webster Company and delivered one of the most interesting lectures ever heard on the campus. He spoke on one of the important present-day and future problems that this country is called upon to solve, one that is especially important to the West. His subject was the water power development of the great potential West, and he illustrated his talk with slides on the Caribou Hydro Electric Development. He explained fully the problems and difficulties arising in the construction of these great plants, the working of the stations, and expounded the tremendous future of the white coal development in this country.

There were about one hundred and fifty members of the association present and they were greatly impressed by Mr. Northrup's address. After a short talk by Charlie MacAnally, the president of the Association, refreshments and smokes were served and the meeting adjourned with every man satisfied that his evening had been well spent.

HIGHWAY ENGINEERING COURSE

The brief course in Highway Engineering that was given by the Civil Engineering Department last winter proved such a success that it will be repeated this year. The course will be the same as that of last winter except that the course in Surveying will be omitted and courses in Highway Maintenance and Contracts and Specifications will be added.

Much of the instruction will be given by outside men holding responsible positions in Highway Engineering. Among them will be Mr. H. E. Hilts, '05, and Mr. Julius Adler, '08. Mr. Hilts is Principal Assistant Engineer of the Pennsylvania State Highway Department, and Mr. Adler is with the Bureau of Highways, City of Philadelphia.

The course is intended for men who have had experience in road building and will extend from January 23d to February 10, 1922.

In conjunction with the brief course there will be a joint meeting of the Committee on Design of Bridges of the A. S. C. E. and the Committee on Bridges of the Associated State Highway Officials. These committees will discuss specifications for highway bridge design and will attempt to arrive at a standard set of specifications.

The A. S. C. E. Committee will consist of H. B. Seaman, Brooklyn, N. Y.; H. C. Baird, New York City; C. E. Hudson, Professor of Civil Engineering, Brooklyn Polytechnic Institute; Milo S. Ketchum, Director of Civil Engineering, University of Pennsylvania; A. F. Robinson, Chicago; F. E. Turneaure, Dean of the College of Engineering, University of Wisconsin, and J. R. Worcester, Boston.

A. S. C. E.

The University of Pennsylvania Branch of the American Society of Civil Engineers has been actively supporting the affairs of the Engineering Association but has not yet held any meetings of its own. Plans are under way for a smoker to be held in the near future, and an interesting program is promised by President Foppert.

ENGINEER ELECTED TRUSTEE

At the last meeting of the Board of Trustees of the University it was announced that Charles Day, '99, had been chosen to fill one of the vacancies on the Board.

Mr. Day is a member of the firm of Day and Zimmerman of this city. He graduated from the engineering department of the college in '99 and received his M.E. degree in '03.

THE WHITNEY SOCIETY

The officers of the Whitney Society have arranged several interesting programs for the meetings which are to be held during the coming winter. Some of these will be presented in conjunction with the Engineering Association and others will be exclusively for the members of the Society. A greater membership among the student body is needed to make the work of the Society successful.

TRIPS

The season of inspection trips is with us, and a number of the classes have been taken to view various works of engineering interest in and about the city.

On November 8th, the Senior Civil Engineers went to Queen Lane to view the new construction work at the filter plant. Under the guidance of Professor Pardoe they inspected the work that was going on and that which has been recently completed.

The same class, on the afternoon of November 18th, went with Professor Berry to see a concrete building in process of erection. The building inspected is being erected by Wark Company for the Mayer Baking Company.

The Junior class of Electrical Engineers took its first trip on November 29th. They visited the plant of the Electric Storage Batteries Company at Nineteenth and Allegheny Avenue. Mr. Seeley was in charge of the party, which was guided through the plant by Mr. Hunt, of the Electric Storage Batteries Company.

Our Show

The Men About Towne will present their annual production on the Evenings of December 14, 15 and 16.

The show this year is, "All for Love" or "The Plumber's Bride," a comedy in anything from one to nine acts

Dancing after the performance.

Let's support it; it's OUR show.

ALUMNI

The Engineering Alumni Association held a meeting on Saturday evening, December 10th. An invitation to attend this meeting had been extended to all members of the senior engineering classes, and as a result there was a large attendance. Dinner was served in the Houston Club at six o'clock. At eight-thirty the meeting moved over to the Engineering Building, where it was treated to an exclusive first showing of the annual Engineers' Show, presented by the Men About Towne Club. The show, a musical comedy entitled "All for Love or The Plumber's Bride", was a huge success and was greatly appreciated by those present. This is the first time the Alumni Association has held a meeting during the school year, the meetings formerly having been held in June at the close of the school year.

Personal Notes

Arthur B. Stitzer, '99, holds the position of Chief Engineer of the Republic Engineering Company, and resides at 486 Mountain View Avenue, Orange, N. J.

W. M. Shallcross, '04, is with the Allen-Bradley Company in Milwaukee, Wis. He is living at 895 Hackett Avenue in Milwaukee.

A. D. Wolff, Jr., '07, is with the New York City Railroad in Albany, N. Y. His home is in Hudson, N. Y., at 11 Rossman Avenue.

Richard G. Miller, '09, is a contracting engineer for the Roberts & Schaefer Company, builders of coal and mining plants. He is in charge of the West Virginia, Va., and eastern Kentucky territories. His home is in Huntingdon, W. Va., at 527 First Street.

Robert E. Garrett, '10, is assistant district sales manager of the Gulf Refining Company in Philadelphia. He is living at 56 Estaugh Avenue, Haddonfield, N. J.

Albert W. Whitaker, Jr., '13, is assistant superintendent of the Aluminum Company of America in Massena, N. J.

John Marshall Clark, '14, is with the Sherwin Williams Company of Chicago, Ill. His home in Chicago is at 10,949 Vernon Avenue.

Henry Foulds, '14, is manager in Argentina of a large American firm. During the war he spent two years fighting in France, having entered the service as a private and before being discharged was promoted to the rank of captain.

J. P. Eyre Price, '16, was a nominee for the Council of the city of Chester at the recent election. While in college Mr. Price was secretary of his class and a member of the football team.

Marshall C. Smith, '17, is leaving the Barrett Company, where he has been employed since graduation, to go in business with his father, Marshall E. Smith, at 724 Chestnut Street, Philadelphia.

G. Justice Mitchell, '10, is with the Chicago branch of the Autocar Company located at 925 W. Jackson Boulevard, Chicago.

W. E. Dunn, '11, is with the Electric Storage Battery Company and is located at 1700 Marquette Building, Chicago, Ill.

Edward H. Ten Broeck, '17, recently left the employ of the Standard Oil Company of New Jersey to take a positon as sales engineer with the Griscom-Russell Company of 90 West Street, New York City.

(Continued on page 31)

PRODUCTION AND USE OF ASPHALTIC PRODUCTS FOR ROADS

(*Continued from page 19*)

required for asphalt block in order to allow for handling without injury. Considering the other three types the following should be noted. Other conditions being the same, penetration of the asphalt decreases as the mineral aggregate becomes finer. For each type the penetration decreases as traffic becomes heavier and in like manner the penetration decreases as the climate becomes warmer.

PENETRATION LIMITS FOR ASPHALT CEMENT

Type of Pavement	Traffic	Temperatures		
		LOW	MOD.	HIGH
Asphalt Macadam	Light	120–150	90–120	80–90
	Moderate	90–120	90–120	80–90
	Heavy	80 90	80–90	80–90
Asphaltic Concrete	Light	60–70	60–70	50–60
	Moderate	60–70	60–70	50–60
	Heavy	50–60	50–60	50–60
Sheet Asphalt	Light	50–60	50–60	40–50
	Moderate	50–60	50–60	40–50
	Heavy	40–50	40–50	30–40
Asphalt Block	Light	15–25	15–25	10–15
	Moderate	15–25	15–20	10–15
	Heavy	15–20	10–15	5–15
Grouted Joint Filler	All	80–100	60–80	50–70
Poured Joint Filler	All	40–50	40–50	30–40

Asphalt Construction

The use of asphalt in the construction of asphalt macadam, asphaltic concrete and sheet asphalt pavements has been covered in other papers presented at this Conference and it is therefore unnecessary to consider them here in detail. Each possesses some characteristic which particularly fits it for use under a given set of conditions. The asphalt macadam is the simplest and often the least expensive type and requires the smallest outlay in construction equipment. Asphaltic concrete may almost invariably be made to utilize

available local materia to a considerable extent. Of all the higher types of pavement sheet asphalt is the most extensively used in cities.

Asphalt Block Pavements

The asphalt block pavement is constructed of blocks composed of a dense fine aggregate asphaltic concrete. These blocks are manufactured at a central plant and sold directly to the consumer. The asphalt block plant is similar in many e pec s to an ordinary paving plant but is equipped with powerful hydraulic presses for moulding the block from hot asphaltic concrete. Upon emerging from the press the blocks are carried on an endless belt under cooling water and are then stored in piles until needed.

In the pavement the blocks are set very close together upon a thin cement mortar bed and are not rolled. A light covering of sand is used to finish off the pavement.

Upon being subjected to heavy traffic the asphalt blocks frequently amalgamate at the surface so that the joint spaces are practically eliminated and the pavement closely resembles sheet asphalt. When, however, the asphalt cement is very hard and the traffic relatively light the appearance of a block pavement is retained. To reduce slipperiness on steep grades the blocks are sometimes laid with cement grout joints which are tooled back to a depth of one-half inch. Special forms of anchor block having a projection which is forced into the mortar bed are sometimes placed in the pavement in single courses where shoving under traffic is otherwise likely to occur.

Use of Asphalt Filler

Asphalt is widely used as a filler for both brick and stone block pavements. One of the chief advantages of the asphalt filler is that it does not produce a rigid monolithic structure. The asphalt serves as a protective cushion to the brick, prevents cracks and efficiently waterproofs the pavement. By its use the noise of traffic is greatly reduced and repairs are readily made.

In the case of brick pavements a blown type of hot asphalt cement is flooded over the pavement after the bricks have been laid and rolled. It is then squeeged into the joints and over the entire surface which is finished with a dressing of sand, thus producing an asphalt mat.

In stone block pavements a hot grout of asphalt and sand is used in like manner.

In constructing monolithic pavements it is necessary to make adequate provision for expansion and contraction. This is most frequently done by inserting longitudinal and transverse joints where needed. Joint slots

are constructed extending the entire depth of the pavement and these are filled with a compressible or elastic material.

Blown asphalt is widely used in the construction of expansion joints and when melted may be poured directly into the joint slots. In some cases a prepared asphalt filler in the form of premolded strips is inserted in the slots, and the surface of the joint sealed with a hot smoothing iron.

Asphalt is used to a considerable extent in maintaining badly cracked monolithic pavements until it becomes necessary to resurface them. As they appear such cracks should be filled with hot asphalt poured from a narrow spout pot so that a minimum amount overlaps on the surface. The joint should then be lightly sanded. With care such cracks may be filled just flush with the surrounding area so as to produce a reasonably smooth surface. Overfilling creates ridges in the pavement which make rough riding.

MAINTENANCE OF ASPHALT PAVEMENTS

In common with all other classes of pavements, those constructed with asphalt will eventually wear out and must be renewed. With careful maintenance, however, the life of a well-constructed asphalt pavement may be extended over a long period of years. Recent paving statistics obtained from the leading cities of the United States show that the oldest sections of asphalt pavement still in satisfactory condition range from twenty to forty-six years.

The maintenance of asphalt pavements may be considered under two main heads: renewal of seal coat and replacement of wornout spots. In the first case, which involves only the asphalt macadam and the coarse aggregate asphaltic concrete types, the seal coat may be rejuvenated or renewed by a surface treatment with asphaltic oil or asphalt cement and a cover of broken stone, in a manner similar to that used in the original construction.

Wornout or rough spots in the pavement require patching and this is ordinarily done by first cutting out the defective area so as to produce excavations with approximately vertical sides. There are two types of patches: the penetration patch and the mixed patch. The former is made by filling the hole with broken stone of suitable size which is tamped or rolled into place. Hot asphalt is then poured over the stones so as to bind them together, the surface voids filled with fine broken stone and the patch finished with a seal coat. Mixed patches are made by filling the hole with hot mix, preferably of the type used in original construction. Sometimes, however, an emulsified asphalt, which may be diluted with water, is used in the preparation of a cold mix for the same purpose. In any case the mix should be thoroughly compacted so as to form a patch which is flush with the surrounding surface.

When too little or too hard an asphalt cement has been used in original construction, when the aggregate is properly graded, or when the pavement has aged with little or no traffic, cracks sometimes form in fine aggre-

gate asphaltic concrete and sheet asphalt pavements. In such cases it is usually advisable to attempt no repairs to the cracks until the edges have worn away and roughness has developed. The pavement may then be cut back for some distance on each side of the crack and a patch put in.

Merits of Asphalt Pavements and Foundations

The asphalt paving industry could not have reached its present proportions had it not been for the intrinsic merit of asphalt pavements which as compared with other existing types have been given a very high rating in tables of weighted factors prepared by leading engineers.

It is generally recognized that properly constructed asphalt pavements are highly resistant to impact and abrasion under rapidly moving traffic and offer very low tractive resistance. They are impervious, readily cleaned and therefore highly sanitary. They wear slowly and uniformly under traffic and are easily repaired. After years of service they may be resurfaced with little or no waste of existing material and in addition may be opened to traffic a few hours after construction.

Recently the more general use of asphalt foundations for asphalt pavements has engaged the serious consideration of many engineers. In common with other types of pavements, failures are often the result of foundations which are inadequate to meet local subgrade, climatic and traffic conditions. The failure of a foundation will, of necessity, produce an unsatisfac-surface condition if it does not result in the absolute failure of the pavement proper. Under certain conditions, gravel, broken stone, slag and Portland cement concrete may be successfully utilized as a foundation for asphalt pavements, and old roads or pavements of almost any type may be so used. All have their place.

There is one class of foundation involving the use of asphalt, commonly known as black base. It may be of either the asphalt macadam, or coarse aggregate asphaltic concrete type. Extending over a period of forty years black base has been in successful use in a number of cities. It is used extensively in conjunction with an asphalt course in California and Oregon and is generally regarded in that section as highly satisfactory. Because of its peculiar adaptability to withstand modern traffic conditions it appears likely to be much more generally adopted in other sections of the country. The asphalt base is a powerful shock absorber, is waterproof, little subject to cracking, forms a close bond with the overlying pavement and is easily constructed. Experienced engineers are coming to believe that the all asphalt highway has a promising future.

WHY, HOW AND HOW MUCH

(*Continued from page 8*)

short summary of each paragraph. In this way, you make your hand serve as a sort of second eye, and you give your brain, as it were, a double exposure to the facts which you wish to register.

Every one knows that to get a clear picture on a film, accurate focusing is essential. Focusing is likewise necessary to get a clear impression on your brain. The ordinary term for brain focusing is *concentration.* I fully believe that more than half of a student's difficulty is his inability to do this one thing, namely, to concentrate. As a suggestion, try this: Take a piece of cardboard about two feet long and in black letters three inches high print on it the word "CONCENTRATE", and hang it over your desk where you will see it every time you look up. See whether this daily reminder will not help you keep your mind on your work.

The foregoing are just a few random suggestions offered with the hope that they may help answer the question which every student sooner or later asks himself, namely, "Why am I here?"

Condemned Bridges

R. Binder, '22

IT USUALLY takes a disaster to make the people realize the importance of some things. Before the Chester bridge disaster the technical school and college engineer were unknown to many of the general public. The inspector of the Chester bridge, which failed and caused the death of twenty-four persons, was not a technical school graduate. This neglect placed the technical school graduate and the college engineer before the eyes of the public. It placed them one notch higher in the engineering world.

As a second result of this bridge catastrophe, all the bridges in districts just outside of Chester were viewed with suspicion. The various bridge commissions were awakened. All private interests were waved aside in an effort to be honest to the public. Out of this came the condemning of three bridges in Philadelphia.

The South Street bridge over the Schuylkill River, the Fifth Street bridge over the railway tracks near Tioga Street and the Fortieth Street bridge over the Pennsylvania Railroad tracks near Westminster Avenue are now closed to vehicular traffic. These bridges were condemned by Director Caven of the Department of Public Works as unsafe for modern traffic and liable to collapse at any time under a loaded trolley car or truck. The Director also said that u-n less arrangements were made to replace six other bridges in the city that it would be likewise necessary to close them to traffic.

ALUMNI

WEAVER L. MARSTON, E. E. '18, is in the production department of the Liquid Carbonic Company, 3100 S. Kedzie Avenue, Chicago, Ill. Marston is secretary of the Chicago Alumni Club and requests that any alumni taking up residence in Chicago get in touch with him. His business phone number is Lawndale 4070.

LOUIS E. BEITLER, CH. E. '20, is with the Barrett Company, 1200 Otis Building, Chicago, Ill.

PH LIP D. TEN BROECK, '17, is with the firm of John T. Lewis & Company, located at 2545 Aramingo Avenue, Philadelphia.

EMMET JAMES PETERSON, '19, of Sacramento, Cal., is secretary to the Hon. C. F. Curry, M. C., in Washington, D. C., with offices at 246 House Office Building.

P. D. RECH, '19, of Elkins Park, Pa., is research engineer for the Cochrane Corporation, Seventeenth Street and Allegheny Avenue, Philadelphia.

F. HERBERT WHARTON, '19, of Newtown Square, Pa., is with the Illinois Highway Department at 506½ E. Monroe Street, Springfield, Ill.

WILLIAM M. ARTHUR, '20, is a student engineer with the General Electric Company, Schenectady, N. Y. He is living at 1348 Union Street, Schenectady.

ANTHONY J. SCHOB, '20, is in business at 127-29 Catharine Street, Philadelphia. His home is in Lawndale, Pa., at 802 Gilham Street.

DONALD M. STEELE, '20, is now with William Steele & Son, contractors, of this city. His home is at Elkins Park. While a student he was captain of the rifle team.

L. I. KOHN, '20, of 4502 N. Sixteenth Street, Philadelphia, is now employed by the Keebler-Weyl Baking Company as chemical engineer.

WILLIAM M. BRADLEY, '21, is with the Pennsylvania State Highway Department at Smithfield, Pa.

WHITEY GREENWOOD, '16, is with the Globe Dye Works, in Frankford, Philadelphia, Pa.

CLIFFORD FENTON, '16, is in the plant Engineering Department of the Bell Telephone Company. He is living in Hatboro, Pa.

ALUMNI

Charles H. Weizel, '16, is a Mechanical Engineer with the Texas Company, 90 West Street, New York City, N. Y.

Alden R. Sexton, '16, is with the firm of Irwin and Leighton, 126 N. Twelth Street, Philadelphia, Pa.

Powell S. MacCalla, '16 E.E., is in the printing business at 257 Dock Street, Philadelphia, Pa.

C. K. Swift, '15, is with the MacAndrews and Forbes Company of Camden, N. J.

L. D. Jones, '15, is with the Sharples Separator Company, Engineers and Builders of Centrifugal Machinery.

E. L. Brendlinger, '15, is President of the Dill Company of Norristown, Pa.

C. S. Woolford, '15, is Superintendent of the American Can Company, Niagara Falls, Ontario.

P. A. Blatz, '15 Ch.E., is Assistant Works Manager of the Amalgamated Leather Company, Inc.

Dear Alumnus:

You're an awful nice sort of fellow, and we'd like to hear more from you.

Send us

1. News
2. Articles
3 MONEY

for a subscription or two and some ads.

Sincerely Yours

The Journal

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THE TOWNE SCIENTIFIC SCHOOL JOURNAL

March
1922

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U-RE-LITE

THE U-RE-LITE is an appliance WHICH ELIMINATES THE DELAYS, ANNOYANCES AND CONTINUED EXPENSE INCIDENT UPON THE BLOWING OF FUSES. It is an I-T-E CIRCUIT BREAKER enclosed within a specially constructed steel case, from the front of which projects a convenient operating handle. THE INITIAL COST OF THE U-RE-LITE IS THE ONLY COST! It not only gives 100% protection to the motor or lighting circuit, but it also protects the employee from coming into contact with live parts. The U-RE-LITE automatically opens the circuit at a predetermined point or when ever there is a short circuit or overload on the line. It can be closed again in a jiffy by any man, woman or child. Simply turn the handle:

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The Cutter Company, Philadelphia

THE

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Frankford Elevated Railway—View Looking North From Ruan-Church Station Platform, Frankford (Showing Single Column Structure with Track Laid)

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Selecting Pennsylvanians

IN THE past decade the University has grown beyond all proportions and with this growth comes its problems. The greatest problem to be confronted is that of keeping the class of men up to a certain standard. Now in a group of twelve thousand men coming from all sections of this country and foreign countries there is bound to be some men who do not come up to the standard set by our predecessors. This type comes to the school, takes everything they can get out of the school and gives nothing in return. They are not representative Pennsylvanians and we are not willing to acknowledge them as such and their presence reflects on the better type of men. The great question now is whether we want quality or quantity. If we are willing to sacrifice our school's good name and reputation, then take quantity. But if we wish to maintain the good name of the school and the type of graduates, then it is quality that we are after and it is up to every one to see that the right type of men matriculate at Pennsylvania and those who will not make worthy representatives of Pennsylvania be excluded.

Many methods have been suggested to remedy these conditions but the one that appears the most logical is the psychology test and personal interview. In the psychology examination the man's capacity for learning is tested and in the personal interview the personality of the man is tested and those who are going to be true sons of Pennsylvania and those whom we will be glad to welcome to our school will be admitted.

Get On The Campus!

TO MANY of us here in the Engineering Building, the campus seems to consist of the small group of buildings to which our classes are limited. We rush madly down Woodland Avenue at 8.29, wander through a day of classrooms in E. B., Physics Lab or College Hall, and dash up to Thirty-second Street again in the evening.

Is it any wonder that Engineers are accused of being poor Pennsylvanians? It is true that we are kept rather busy at times with our school work, but there is really not one of us who can honestly say that he has not at least a little time for some line of outside activity.

Get into something! If you can't do anything else, just walk around and get acquainted with the campus and with men on other parts of the campus. You will have a better opinion of Pennsylvania and Pennsylvania will have a better opinion of you.

"We Regret to Inform—"

MANY of us carry around the little yellow Book of Regulations and a few of us have even read it. The Eighteenth Commandment in this Engineers' Bible begins: "A student whose standing becomes unsatisfactory at any time may be placed on general probation——"

Oh, yes. General Probation. That's the place bad little Freshmen go to when they die, isn't it? Now that midyears are over, some of us are on Probation and others are wondering why we aren't. It isn't a pleasant sensation, but at the same time there are things which might be worse.

The other departments of the University have a system which differs from that used in Towne. Under the rules of Wharton and College, a man is automatically dropped when he has a certain number of conditions against him. In Towne, the Faculty assigns certain requirements which must be met within a certain time. If these requirements are satisfied, the student is restored to full standing. Thus a man is given the time from June to September, or a certain length of time during the term, in which he is himself allowed to determine whether or not he is to remain in school. The fact that a man incurs conditions does not necessarily mean that he is unfitted for the course that he is pursuing. The transition period from prep school hero to Pennsylvania Freshman is a hard one, and many men suffer in their work through no lack of ability. The automatic exclusion rule causes the dropping from other departments of men who hardly have had a chance to realize that they are really in college. The system in effect in Towne gives the man a chance to prove that he really has the ability and interest to warrant his continuation of the course. Although it may not be perfect, it seems in the end to be more just to the student than any other method yet devised.

But don't get on General Probation just to see what it is like.

Finis

WITH this issue the present Board of the TOWNE SCIENTIFIC SCHOOL JOURNAL finishes its active work and hands over the management of the paper to next year's Board. It seems a bit early to contemplate graduation, but the members of the Class of '22 find that the end of their four years' stay is fast approaching.

The final issue of this year will be edited by the Managing Board which is to guide the policies of the JOURNAL through another Volume. The retiring Board wishes to extend its thanks to those men, both students and faculty, who have helped in the rehabilitation of the JOURNAL, and to express its hope that their continued support will make permanent a paper that is worthy of the name of Towne and Pennsylvania.

FRANKFORD "L"

Political History, Design and Construction, Present Status

(Illustrations Courtesy of the Department of City Transit)

(From statements by Hon. J. Hampton Moore, Mayor of Philadelphia; J. E. Mitten, President P. R. T.; J. R. Conroy, Traffic Engineer; Courtesy of Assistant Director G. T. Atkinson, Chief Engineer H. H. Quimby, and Assistant Engineer H. S. Hipwell of the Department of City Transit; and courtesy of G. Rockwell of the "Evening Bulletin". Particular credit is due Mr. Hipwell for correcting the engineering material.)

J. J. Creskoff, '22

WHEN in 1912-13 the Department of City Transit prepared plans for a system of subway-elevated lines provision was included for the Frankford "L", an elevated line through the northeastern section of the city. At the time of its proposal the general plan was designed more to serve and develop large areas of uninhabited territory than to supply any great measure of immediate relief. Property owners and business men along the suggested routes interested themselves energetically in the campaign then made with the result that on July 20, 1916, the Select and Common Councils of the City Administration authorized by ordinance the construction by the city of the aforementioned system.

The next step was to prepare for the operation of the city lines when built, and in furtherance of this project the Philadelphia Rapid Transit Company was asked to submit provisions of a contract for same. This was done, but City and P. R. T. being unable to agree on the constituent provisions of such a contract, the City Councils requested Director Twining of the City Transit Department to prepare a form of lease of the city's future high speed lines to the Philadelphia Rapid Transit Company. He did so and P. R. T. when proffered this contract accepted, February, 1918.

The contract duly signed and executed on behalf of the city and company was next submitted to the Public Service Commission for approval. The Public Service Commission, however, after months of deliberation, refused its approval of the contract mainly because of a clause stating that the rate of fare should always be made sufficient to produce a cumulative return of five per cent. upon P. R. T. capital stock and city money invested in transit, whereas the commission declined to accept any basis of fare adjustment other than that provided by a valuation of the company's used and useful property. This valuation commenced immediately thereafter has just been completed. However, the city's and company's experts' estimates vary widely, the latter's evaluating P. R. T.'s physical property and intangible values at $290,000,000, whereas the city contends that $150,000,000 would be a fair price.

At this writing city and P. R. T. are about to conclude an operating agreement for Frankford "L". This, a temporary contract, entered into only because of the popular demand for the "L" service, was submitted to the commission jointly by the Philadelphia Rapid Transit Company and Hon. R. Weglein, President of the City Council, on January 17, 1922. The Public Service Commission approved two of the proposed provisions of the submitted lease. These provided that the same rate of fare shall be charged on the Frankford "L" as upon the rest of the Philadelphia transit system and that the city shall have the right to terminate the lease after the expiration of five years. The way is now paved for the adjustment of the rental question which is at present the sole deterrent to the final approval of the lease which will open the Frankford Elevated to the public.

The Frankford line begins at a connection with the Market Street Elevated near Front and Arch Streets and extends in a north and northeasterly direction for a distance of 6½ miles to Bridge Street in Frankford. The elevated structure was designed for electric car service and the loading used was a 100,000-pound two-truck four-axle car with an impact allowance of twenty-five per cent. The stiffness of the structure was made to comply with traction loads, wind stresses and loads due to centrifugal forces, a general factor of safety of four being used. The chief objects aimed at throughout the design were rigidity, permanence, noiselessness

FRANKFORD ELEVATED RAILWAY—VIEW OF COMPLETED STRUCTURE WITH TRACK LAID
(Showing Station, Connecting Passage, Platform and Overhead Passage at Margaret Street, Frankford)

of operation and safety and convenience of the passengers. Recent tests indicate that the engineers have succeeded beyond their highest expectations.

Actual construction work on the "L", begun on September 13, 1915, has been marked by unusual freedom from accidents and unforeseen difficulties. The soil along the major part of the route being for the most part of a clay and gravel composition furnished good bearing power and hence very little difficulty was encountered in placing the concrete foundations. Here and there, however, rock was met, and, below Girard Avenue, a short stretch of quicksand necessitated the sinking of piles to support the column foundations.

The transverse bents, in general, are of two column construction. The typical two column bent consists of two built-up columns, of two channels—one Bethlehem "H"-concrete filled section, supporting a transverse girder of the bull-nosed type

On one stretch of the elevated, however, single column bents are used on account of the narrow width of the sidewalks in that district. These columns are located between the two surface tracks thus avoiding any loss of walking space.

Bents are connected at the center and ends by three longitudinal girders carrying the tracks. At stations additional longitudinal girders are provided to carry the platforms. Longitudinal girders are the ordinary type of Pratt truss with angle posts or compression members. The tension members, in general, consist of plates, and the top and bottom chords of angles with the addition of plates when necessary.

The roadbed is a solid structure throughout. It consists of Bethlehem "I" beams placed 5′-6″ center to center (at right angles to the rails) and connected by concrete jack-arches supporting impregnated, creosoted wood ties on stone ballast. Ninety-pound A. S. C. E. track rails are used. Guard rails are generally 67½-pound Russian type rails and are placed on inner rails only. At points of particular danger in case of derailment, such as sharp curves, cross-overs between tracks and at all unusually high points along the elevated, 90-pound A. S. C. E. and A. R. A. rails are used being placed on both rails for additional safety. Gage

of the tracks is 5′-2¼″ center to center. Opposite the platforms of the stations the rails are supported on short wood ties imbedded in concrete, ballast being dispensed with so as to secure a more easily flushed, sanitary floor.

Each side of the entire length of the elevated between stations is provided with a two-foot wide concrete footwalk supported approximately every five feet. This provides a safe method of exit for passengers leaving a stalled train.

The stations, which are twelve in number, not including a terminus at Bridge Street, are spaced on the average a distance of one-half mile apart. The stations are brick, steel and concrete structures, pleasing in line and color, designed in an unpretentious, sober type of architecture and amply illuminated. Passengers on entering will go up by easy stages and cross a bridge at platform level to reach the cars.

A distinctive feature of the Frankford "L" is the fact that the stations are built on private property taken over by the city. The sidewalks in many places being so narrow that they could not be encumbered with entrance or exit stairways, a solution was found by condemning private property at corner sites and erecting modern stations in their place inside the building lines, in this way leaving the sidewalks unobstructed. This plan is a decided improvement over the stations existing along the Market Street Elevated Line.

The interiors of the stations are in just as good taste as their exteriors. The floors are steel troweled cement floors with carborundum worked into the top surface, this making them exceedingly hard and wear resisting. The roofs consist of five-ply tar and gravel roofing on reinforced concrete slabs.

The station platforms, designed to accommodate ten-car trains, are of reinforced concrete construction supported on steel girders. Platforms are steel enclosed between the columns at the rear of the platforms, the enclosure and the roof being supported on steel columns with cantilever tops so as to eliminate all columns in centers of platforms. Roofs over the platforms are so placed that they overhang the cars using the stations, thus protecting passengers entering and leaving cars during stormy weather.

To provide for storage and repairs to cars a terminal yard was built at Bridge Street designed to furnish storage room for one hundred cars. In addition the yard contains a completely equipped inspection shop, four hundred feet long and wide enough to include three tracks the full length of the building. The shop can, if necessary, accommodate twenty-one cars simultaneously.

The city is now building and completely equipping three-power substations for transforming 13,200 volts A. C. to 550 volts D. C. The substations are so located as to conveniently feed power at the center and ends and are interlocking in order to meet the needs of an emergency, such as the temporary breakdown of any one station. The main transformers will be of the rotary type and will be of 2000 K. W. capacity. The stations will also be equipped with smaller transformers for transforming such current as may be required for operating the signal systems, emergency controls and station building and platform lighting.

Signalling will be of the electric automatic control type, with a man-controlled signal tower located at Arch Street to oversee trains crossing the Market Street "L" tracks, and a signal tower at Bridge Street to control trains to and from the terminal yard. Emergency signal houses will also be provided at intermediate points between the two main signal towers for the operation of emergency cross-overs.

The cars, which are of all steel construction, are fifty-five feet long, eight feet ten inches wide and weigh 86,000 pounds, which is about ten per cent. heavier than the Market Street Elevated cars. The seating capacity is fifty-one passengers, with total room for about two hundred. The cars are built without vestibules, having three doors on each side so placed that the flow of passengers in or out will be expedited. The cars are equipped with the latest electric coupling apparatus in which all electric connections between cars are made automatic at the time cars are coupled together. The mechanism for operating the doors will also be controlled electrically. Doors are equipped with automatic devices, which, if closing upon a passenger alighting or entering the car, will not harm him and will at once reopen and release the passenger and immediately close, the train being unable to start until all doors are closed. Brakes are of combination electric and pneumatic control, designed in such fashion as to make it practically impossible for both controls to fail at the same time. In addition all cars will be provided with emergency hand brakes. Automatic speed control at entrances to blocks, and appliances for automatically stopping a train if the motorman runs past a danger signal will also be installed as well as other safety devices.

The reader by this time has most likely inferred that the design and construction of the Frankford Elevated Railway's superstructure, station buildings, platforms, canopies, sub-stations, sub-station equipment and passenger cars represent the very latest and most up-to-date ideas and equipment in electric railway develop-

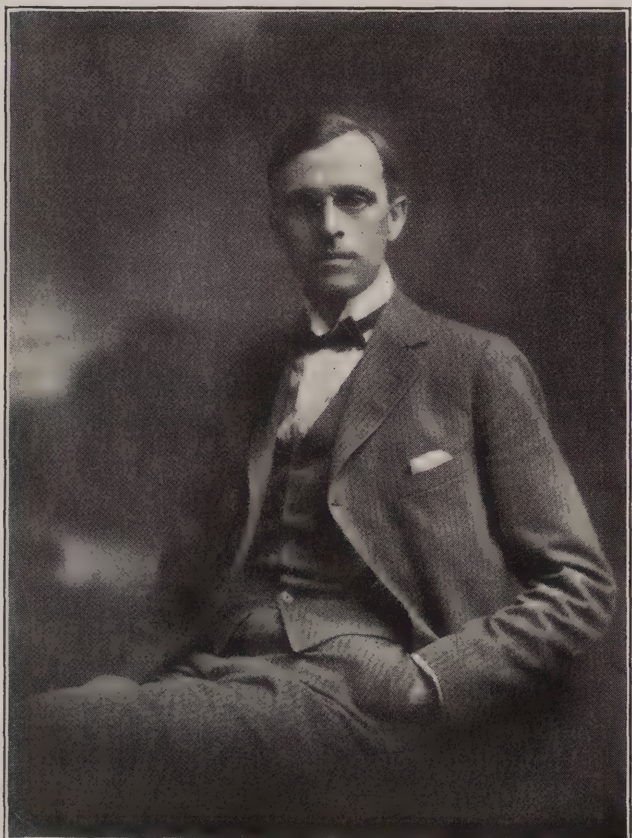
(*Continued on page 30*)

The Staff and Line

AN INTERVIEW WITH *Charles Day, '99 (C)*

JOHN P. MURDOCH, JR., '23

(EDITOR'S NOTE—*Mr. Day graduated from the engineering department of the College in '99, and received his M.E. degree in '03. He is a member of the firm of Day and Zimmerman, of this city. As was announced in the last issue of the "Journal", Mr. Day was elected to the Board of Trustees of the University*).



THIS may seem a rather strange heading for an article concerning what the future holds for engineering, but as I shall point out, it really sums up the whole matter. As all of you know it is the staff officers, and the line officers who are their immediate subordinates, who are primarily responsible for the successful functioning of an army. Engineers are the staff and line officers of industry and you who are studying engineering are the cadets.

When you are graduated from the engineering school you will take your place as an officer in the line in a very minor position at first, it is true, but nevertheless you will at least be part of the great machine, taking an integral and necessary part in industry. Of course every undergraduate looks forward to the day when he will be a Steinmetz or an Edison, men who occupy high positions on the general staff of industry. These men have through their efforts caused the establishment of mighty industries, employing thousands of men. Men of such rare technical skill and vision are necessarily few and they make their own future. There are among your number, perhaps a genius or two, but I am primarily concerned with the ordinary man. This ordinary man can attain to unlimited heights if he is properly prepared and well trained.

We should, therefore, be more directly concerned with the work of the line, for here the larger number of men are needed and from them the staff officers are chosen. Where we have men in numbers we have the need of direction and co-ordination of their efforts—administration in all its aspects. Now the function of directing and administrating from its simplest form, in the case of the foreman of the labor-gang to the complex circumstances confronting the chief executive is difficult to carry out in any case, and is something that can be taught in part only.

Of one thing we can rest assured, however; that real success is founded invariably upon a basic knowledge and understanding of the work to be directed and the service to be rendered. But these fundamentals, in the case of the great producing businesses, no matter what kind, are concerned with technical engineering principles, with a knowledge of design, of processes, materials and structures. Consequently, a technical education which presupposes at least a general acquaintance with such factors, supplemented by a more exhaustive understanding in some restricted department of engineering, establishes a logical basis upon which to build when preparing for almost any industrial service.

The young graduate will soon learn that many questions bearing upon the handling of labor, others concerned with finance (from cost keeping to the sale of a bond issue), and maybe most important of all the question of sales or distribution, are ever present in the administrative field. It is argued that many men who do well at college may not make good salesmen, nor possess the qualifications to settle a strike, but this does not mean that industrial leadership, as presented in its many aspects, is not a legitimate objective for graduate engineers. Some men will, of course, go further in Staff work than in the Line, but the point I wish to make is that the opportunities offered by all departments of industry are most easily realized by men technically trained at college.

All that I have said may seem self-evident but in it I hope you will find the answer to your question. The future for engineers who see clearly the opportunities that await technical graduates, who realize that while they cannot know too well their textbooks, that after all for the vast majority the knowledge gleaned from them forms but a background or a point of departure, and is but a fraction of what makes for business success—the future for such men is the future of industry, whether it be manufacturing, transportation, construction or any other activity which is concerned *primarily* with the application of engineering principles. Monetary reward for the majority will depend upon the distance traveled in the assumption of administrative responsibility.

During the past decade men with engineering training have been assuming in increasing numbers positions of responsibility and importance in business generally. It is on this account that wherever I have an opportunity I urge undergraduates to supplement, in every reasonable way, their technical education through acquiring an understanding of business procedure generally, of the usual financial transactions entering into business, present-day employment problems, etc. I am not suggesting further courses of formal study but rather that there should be stimulated a day-to-day interest in questions, the importance of which are likely to be underestimated unless their possible bearing upon future business success is really appreciated

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Licensing the Engineer

R. W. Chew, '22

THE licensing question has long been a source of much contention among engineers. The movement in favor of licensing has been growing rapidly during the last few years and state after state has fallen into line. It is only a question of time till every state in the Union will have enacted laws to control the practice of professional engineering.

There are two fundamental reasons why engineers should be registered or licensed. In the first place, the public should be safeguarded. The life, health and property of the public are in the hands of the engineer. In all states the practice of law, medicine and dentistry, and other vocations affecting life, health and property are controlled by law. Why should the engineering practice not be regulated by law?

The second reason is to safeguard the engineering practice itself. The legal status resulting from licensing will help in the development of a professional consciousness, and also in impressing the importance of the profession upon the public. The public will feel that the engineer occupies a more important place, while discipline by a board of engineers will secure wide publicity and have a favorable reaction.

However, many prominent engineers do not favor licensing laws. They say the public is sufficiently protected by the safeguards that exist in the construction of buildings and other engineering work, through supervision by competent commissions and engineers, through building laws and other special laws requiring official supervision and approval of plans, inspection of work in process and of finished work. If such measures are not sufficient, the wise policy, some think, is to add to them and amend them in such a way as to cure their defects.

Moreover, opponents of the law state, a person who became registered would be in the eyes of the law fully competent to practice every branch of engineering, regardless of the field in which his training or experience had been. They argue that the various fields of engineering are not closely associated enough to have one blanket law covering the registration of every kind of engineer.

The licensing of engineers would not effectively safeguard the life, health and property of the public, say opponents of the law. In all the big engineering failures, the engineers involved would have been able to qualify under any probable registration commission.

Another argument against licensing is that because of conflicting state laws, engineers whose practice lies in several states would be greatly inconvenienced. However, this difficulty might be obviated by reciprocal agreements between the states, or better, by a national uniform licensing law.

In 1920 Engineering Council's Committee on Licensing proposed a model licensing law. This law was the result of fourteen months of study and discussion by a committee of fifteen prominent engineers representing thirteen states and nine branches of engineering practice. Most of the existing state license laws follow in their main provisions this model law. This law covers not only engineers, but also architects and surveyors. In it, no examinations are provided for, but each applicant for registration must submit under oath evidence of having satisfactory qualifications to practice. Most of the existing state laws, however, provide for some kind of examination.

According to Engineering Council's model law, the applicant must be at least twenty-five years of age, of good character, a citizen of the United States or of Canada, or must have declared himself for citizenship, and must speak and write English. He must have had six years of actual practice immediately prior to application, one year of which must have been in responsible charge of work. Teaching and studying engineering is considered active practice. A total practice of ten years, or graduation from a four year engineering course and four years' active practice, qualify a candidate for registration. Likewise full membership in a recognized engineering or architectural society will be considered sufficient evidence of the candidate's eligibility unless other known facts disqualify him. Revocation of registration is to follow conviction because of fraud, deceit, negligence, incompetence or misconduct.

A big problem yet to be satisfactorily solved is whether or not corporations and partnerships composed partly of non-engineers should be allowed to practice engineering. Engineering Council's model law permits engineering corporations and partnerships to practice engineering provided those in charge of the designing or supervision which constitutes engineering practice are licensed engineers. However, many engineers believe that, as in the professions of law and medicine, no corporations or unrestricted partnerships should be allowed to practice.

Notwithstanding all these arguments, the principle of licensing is being accepted. Seventeen states now have licensing laws, and in Canada only three provinces lack them. Those states which have enacted laws to control the practice of professional engineering are Colorado, Florida, Idaho, Illinois, Iowa, Louisiana, Michigan, New York, Oregon, Virginia, Wyoming, Indiana, North Carolina, Pennsylvania, Minnesota, Tennessee and West Virginia. The last named six states joined the group in 1921.

Pennsylvania's license law was signed by Governor Sproul in May of last year. The act becomes effective June 1, 1922. The bill follows the model law of Engineering Council with modifications to suit local requirements. The American Association of Engineers, mainly through the Philadelphia, Harrisburg and Pittsburgh chapters, were the main sponsors of the bill. Governor Sproul has made the following appointments to the state board:

Richard L. Humphrey, consulting engineer, Philadelphia.

Henry S. Drinker, former president Lehigh University.

William McClellan, consulting engineer, Philadelphia.

A. B. Clemens, International Correspondence Schools, Scranton.

Samuel D. Foster, consulting highway engineer, Pittsburgh.

In the order named above the members of the board will serve respectively five, four, three, two and one years.

Thus we see, regardless of our own views on the subject, we must submit to licensing and registration. However, if all men who call themselves engineers were properly trained, thoroughly experienced, pledged to co-operate with each other, and were actuated only by unquestionable motives, license laws would not be necessary. But as such is not now nor ever will be the case, we must have laws to protect the public on the one hand and representative members of the profession on the other.

Water, Water Everywhere—

Abraham Robinson, '22

(*Illustrations Courtesy of the Permutit Company*)

THOUGH you can still get a drop to drink. This is not a prohibition preachment; the editor would not permit that, and our readers might object. On the contrary we shall endeavor to poison your minds against that most harmless and blameless of liquids, water, the symbol of all that is clean and pure and sober. Its scenic and lavatory uses have long been appreciated, but it is only of recent years that social prominence has come to it. It is upheld, praised, even drunk, they tell us, by others than public orators; its purity and harmlessness are commented upon as matters of fact.

But be warned. Within the depths of the molecule, where the two hydrogen atoms lie equably linked to their oxygen lord and master, lurk danger and destruction.

It is the gentle rain that drippeth from the heavens that comes under censure. For our natural water supply comes to us by the aerial route. In its headlong flight it yet tarries long enough to pick up oxygen, carbon dioxide and any other stray gases floating around, while in its underworld journey it accumulates more solid and more objectionable material, compounds of lime, magnesia, iron and so on. After these wanderings then it returns to us as a kind of prodigal son, or daughter, and we are expected to receive it to our hearts, our boilers, our radiators, as something pure and clean. Whereas, as you may see, that is what it is anything but.

Fig. 1. Scale Deposits in Pipe Lines.

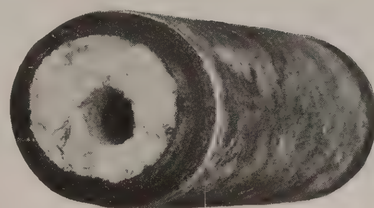

Fig. 2. Showing Scale Deposited in Pipe Lines.

When pure water is fed into a boiler nothing but steam comes out. But the raw water supply for boiler plants invariably contains hardness, that due to calcium (lime) and magnesium salts being the most common. The hardness is estimated in degrees. In this country one degree of hardness corresponds to one grain per gallon (.017 grams per liter) of dissolved salts.

When hard water is continually fed into a boiler and only steam comes out, the hardness is left behind in the boiler in the form of a crust or scale. Water of only a few degrees hardness leaves quite a scale in a short time of use, and even the most ordinary water usually has as many degrees as a visiting general.

These scales are composed of some of the best natural heat insulators known. Magnesium in particular, in the form of its oxide, is an extensively advertised insulator, and calcium is almost as good. In fact it would be rather difficult to devise an insulation much more effective than these scales of high magnesium and calcium content. A large portion of the heat applied to the boiler is wasted in overcoming this internal resistance then; moreover, since the iron is no longer in direct contact with the water it is heated to a higher temperature and may even become red hot. It then changes gradually to the brittle oxide and the life of the boiler is greatly shortened. Crusts of one-eighth inch thickness, which are not uncommon, reduce boiler tube evaporating effectiveness by as much as twenty-five per cent.

Then there is the sludge. Sludge is the suspended and loose precipitated matter as distinguished from the

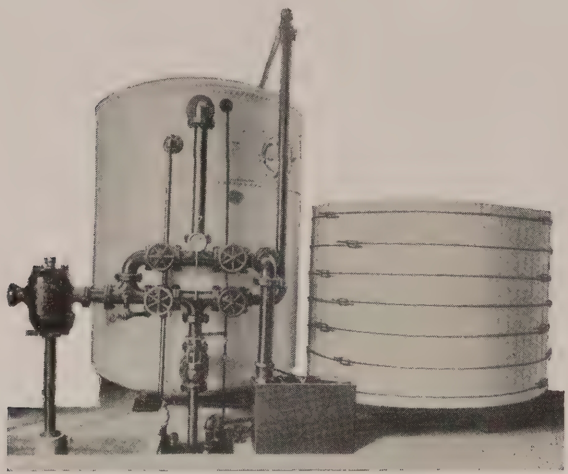

Fig. 3. Zeolite Water Softener.

solidified scale. Together with any mud that may be in the water it travels around to all parts of the boiler and is almost as effective as the scale in preventing proper transmission of heat. Foaming in the boiler can also be blamed upon the suspended matter.

Cleaning and repair items are another large expense. Even to take a boiler or other hot-water apparatus out of commission for scraping represents a service loss that has its dollars equivalent, while labor and materials are more tangible expenses.

Figures 1 and 2 show innocent pipe connections in the last stages of the scale disease. In both cases the scale has almost entirely sealed the pipes, reducing flow and rendering them worthless as heat conductors. Scale forms not only on boiler tubes but on any wetted surface to which heat is applied.

The problem of satisfactory operating conditions boils down to removing the scale forming materials before they have a chance to deposit. This can only be effected by distillation or by the Zeolite process. Distillation, a very familiar domestic procedure nowadays, is reliable and thorough, but since it involves the boiling of water that is later to be put to this very use perhaps, it is by no means economical.

The Permutit Zeolite process removes hardness by exchanging for it harmless softness. Permutit, the softening substance, is an artificial zeolite, a coarse, insoluble sand. Chemically it is a sodium aluminum silicate which we will formularize as NaP for the sake of simplicity, not to mention the fact that we don't know its formula. The sodium is loosely attached to the rest of the molecule and when hard water is filtered through a bed of this sand an instantaneous and agreeable change takes place, harmless sodium salts being formed while the unsuspecting Permutit absorbs all the hardness. The exchange takes place in a tank like the one on the left in Figure 3.

For instance water hard with magnesium sulphate is softened according to this simple equation:

$$Mg\ So_4 + 2\ NaP = Na_2So_4 + MgP_2$$

The sodium salts formed are harmless and non-precipitable.

When the Permutit has reached its limit of exchange it is regenerated by means of a common salt solution contained in the auxiliary tank shown in Figures 3 and 4. Thus:

$$2\ NaCl + MgP_2 = 2\ NaP + MgCl_2$$

and the Permutit is once more ready for the job of softening. The $MgCl_2$ which contains all the accumulated hardness and the excess salt solution pass out through the sewer to an inglorious end. The recharging may take place at night when the set is inactive, or two softeners may be placed in parallel to give continuous twenty-four-hour service, one softening while the other is being charged.

The set shown is a typical softener for boiler feed purposes. Smallness, compactness and simplicity of operation are some of its features. After a few valve settings it is automatic in operation and can deliver 30,000 to 40,000 gallons of zero hardness water daily.

The elimination of scale-forming impurities is not as simple a problem as the two equations above. A quantitative analysis of the water supply will reveal what it

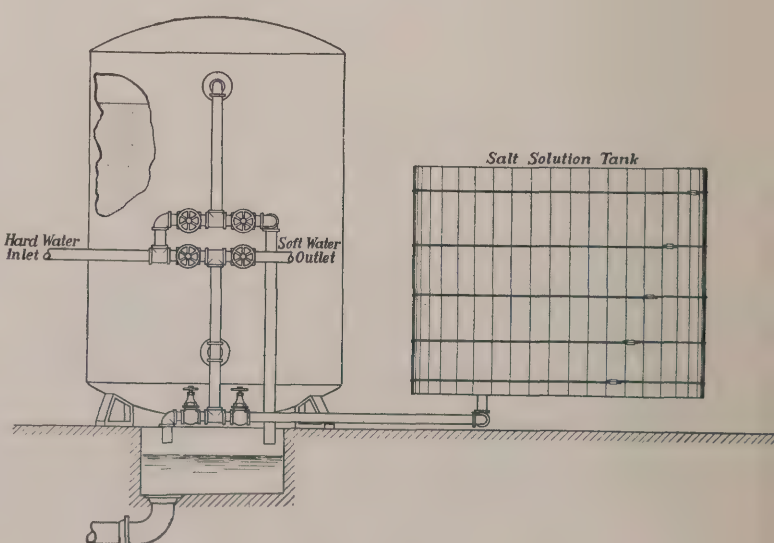

Fig. 4. Line Diagram of Softener in Fig. 3.

contains besides water—iron, manganese, suspended mud, and coloring matter are complications, and their presence and amount vary with location. Often such auxiliary apparatus as aerators, filters and clarifiers must be used in series with the softener.

Nor is the question of a supply of clean, soft water of interest to power plant engineers alone. Every industrial process must use water at some time or another in its operations; textile and paper mills, dye works, drug and chemical plants and ice houses suggest at once the necessity of a supply of clear, soft, iron-free water.

For every new wrinkle in a water problem there is a remedy. Large companies, such as the Permutit, are equipped with a wide variety of products that enables them to effect a correct and economic solution in every case.

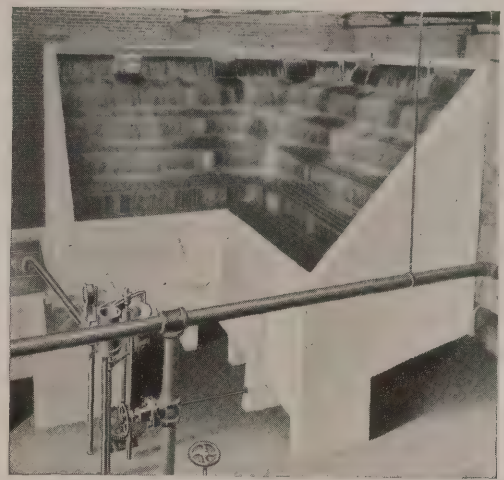

Fig. 5. Aerator in a Permutit Set for Removing Iron from Water

A Glimpse of Marine Repair

G. Nelson Soeder, '23

FEW people who have made ocean voyages or traveled on the water to any extent realize the vast amount of repair work that must necessarily be done upon a ship at the end and even during the passage of a trip of an ocean liner. Occasionally we hear of a ship having an accident at sea, and of how the ship was quickly repaired in mid-ocean and allowed to continue its voyage, but these cases are the exceptions. Usually at the end of a trip the entire machinery of the ship must be overhauled in a short time in order to make its next voyage at the scheduled time.

The machinery in a ship must be kept in perfect condition. There are various factors that enter into the ordinary wear and tear on a ship's machinery. Take, for example, two engines practically the same and put one into stationary use in a power plant and the other at work driving the propeller shaft of a large ship. The load on the one in the power plant is practically constant, the engine even can be shut down at intervals for rest—incidentally machines need rest as well as human beings—but in the caseof the engine on the ship conditions are much different. It must work for a relatively long period, even to several weeks, without a shut down. This eliminates any chance for a good overhaul during the trip. The load on the engine driving the propeller varies to the extremes. Suppose the ship is going full speed ahead and suddenly the propeller comes out of the water. As full steam is still on and no work is being done the propeller will speed up. The sudden speeding up causes considerable shock to the engine, its supports and bearings. From this condition the propeller enters the water again and full load is again assumed and the propeller is cut down in its speed to normal. This maximum variation of the load, from full load to no load and back to full load takes place in a very short time. It is easy to see that this repeated many times during the voyage causes considerable wear on the machinery.

It is also very difficult to get good lubrication on shipboard. The constant rocking of the ship disturbs the lubrication, and the salt water, which is also present, tends to dry up the bearings. This causes the bearings to wear out in a much shorter time than if they were in use in a stationary engine in a power house.

The salt air has a very peculiar effect on the materials of construction. An ordinary cast-iron pump cylinder, after exposure to the action of the salt air for some time, will change from a brittle form to a variety which is soft and which can be cut in slices with a penknife as readily as cutting the wood from a lead pencil. The iron in this condition is not as strong structurally as the original cast-iron and hence machines, or parts, affected by it are more readily subject to breakdown than if free from any effect of this nature.

In addition to these examples there are many other factors entering into the seemingly large amount of repairs on a ship.

The carrying out of ship repairs requires a corps of marine engineers and machinists who have a broad knowledge of the subject. There is no routine work, every job presenting a different problem from any other, and it is the marine engineer's job, if he is doing repair work, to solve the problem, and what is very important, solve it as quickly as possible.

The necessity of a broad knowledge of the subject is better seen by the aid of an example. The pump cylinder of a large ship broke, close to the end of the voyage, and the ship put into the nearest port and shipped the broken cylinder, by rail, to a repair shop at its final destination, the ship being forced to make its return trip with only a short stay. Because of a tie-up in freight conditions the broken casting did not reach its destination and when the ship arrived the marine engineer, going aboard the ship, found that the pump had been built in San Francisco and there were no blue prints of it to be had a moment's notice. He was therefore required to design part of the pump, which he had never seen complete, to fit the part that was left. The patterns were then made and the casting poured and while still warm it was machined and put in place in the ship and the ship allowed to continue on schedule. This all took place in a few hours.

Marine repairing thus requires a very competent class of engineers, men who can handle the great variety of the work in the most efficient manner.

Coke

C. C. Roth, '23

COKE is produced for two essential reasons; first the manufacture of gas in which coke is a by-product; second, the manufacture of coke for blast furnaces in which gas is one of the by-products. To serve these two purposes, separate and distinct methods are used for its manufacture and the products obtained can easily be differentiated.

While the same kind of coal is often carbonized to secure both classes of coke, and while the temperatures employed in both operations often very closely approximate each other, the results differ to some extent. We find that in the production of metallurgical coke every effort is put forward to produce an article which shall possess the required strength and purity needed in blast furnace work, while the production of gas coke first implies the manufacture of a gas containing the required candle power, the coke being a secondary consideration.

In gas making the coke is produced rapidly and usually at a low heat, in consequence it is of a dull black color and a loose soft texture. This kind of coke cannot be used in a blast furnace because of its lack of strength to hold up the higher layers of coke, ore and slake, but as a by-product it is sold as a fuel. It is slower to ignite than coal but once lit it gives off considerably more heat.

The use of coke in the manufacture of pig iron was first successfully achieved by Darby in England, 1735, and about one-quarter of a century later it became general in the United States. Coke manufactured for the blast furnace is produced slowly and the product is hard and dense. It is of a gray color, a metallic lustre and is a conductor of heat and electricity. Blast furnace coke can not be burned in an ordinary furnace as it needs an excessive chimney draught or an artificial blast.

Coking was formerly largely carried on in piles or mounds, a method similar to that used in the manufacture of vegetable charcoal, but it is now generally done in ovens. These vary in construction and method of heating but can generally be classed into three principal types; the direct heated ovens, the flue heated ovens and the condensing ovens. In the direct heating ovens the heating is done by directly burning

the gas within the ovens, while in the two latter classes the heating is indirect. By indirect is meant the burning of the gas within the dividing walls, and these walls in turn heat the coke. In the flue heated ovens the gas coming direct from the coking is burnt while in the condensing ovens the gas is first cleared of all valuable constituents and then used. As the latter method is the most economical its operation only will be described.

Coking is generally carried on directly in the coal regions or upon a large stream which would make the transportations of both coal and coke cheap. The coal is brought to a shack where it is cleaned and crushed to the desirable size. Crushing the coal as it comes from the mine is necessary in order to produce a good uniform quality of coke. If this were not done, large and small lumps would remain, the former requiring a longer carbonization period than the latter. From here it is elevated to a height slightly in excess of the ovens from where it can be shot into the moving cranes. These cranes, moving back and forth upon the top of the ovens, dump the crushed coal into openings in each coking compartment.

The ovens of a coking plant are usually arranged in tiers of about thirty in number. They are generally about twenty-five feet high, fifty feet long and two feet broad, tapering to allow the pushing out of the finished coke. The ovens consist of a coking compartment and the intervening walls. These walls are again subdivided into two separate compartments. Into the one is fed the gas, secured from the coking, after the by-products have been removed. It is fired by heated air and the flame rising through one-half of the side flues enters the parallel collector at the top and returns downward through the flues of the other half, passing from here out to the chimney. In this way the walls are heated and they, in turn, roast the coals encased between them.

The ovens are charged with a limited amount of coal, secured from the before-mentioned moving cranes, entered at the top of the ovens, through trunnel heads. The coal, as it drops in, forms in piles and, in order to smooth these down, a leveler is used. On one side of the ovens, moving on a pair of rails, is a machine containing a leveler and a pusher. The former's purpose has already been mentioned; the latter is used to push out the finished coke. The ovens are so timed that no two of them will demand the services of leveler and pusher at the same time. When the coke has been completely roasted it is prepared for the pusher and the tall narrow doors at both ends of the ovens are opened. The fact that the coal contracts slightly and that the ovens are tapered make it possible to push the coke directly through the ovens out into a waiting car which is placed at a slightly lower elevation. This car carries the red-hot coke to an overhead tank where it is chilled by a shower of cold water. The coke is then shot into another car at a still lower elevation and carried on to the blast furnace. The advantage in having cars placed at lower elevations lies in the quick transfer of material from one to the other.

During the coking, there is produced a heavy yellow gas, rich in tar, ammonia and lighter oils. This gas is drawn by an exhauster from the top of the coking chamber into a long pipe, through which is flowing a stream of tar. The heavy tars condense and flow into a waiting receptacle. This original flow of tar is kept constant to prevent the adhesion of the condensing tars to the sides and block the flow. From here the reduced gas continues on its way to purification. It is next passed through a series of air and watercooled condensers and scrubbers. This liquid now rich in ammonia is brought in contact with hydrochloric or sulphuric acid and the resulting ammonia salts are packed and sold as by-products. From here it is passed through an oil shower and again cleansed; this time there result the lighter oils. Having removed the tar, benzol, ammonia and lighter oils there remains the permanent gaseous residue, consisting chiefly of hydrogen and marsh gas. Part of this is returned to the ovens for heating and the remainder may be sold to the surrounding gas companies for domestic use.

In following this process through, one essential feature stands out. Here is a process of manufacture in which there results no waste whatsoever. A raw material is subdivided into numerous and useful products with no original material remaining at the end to be called wate or loss.

Doubling the Capacity of the Queen Lane Filter Plant

JOHN LINDSAY, '23

AMONG Philadelphia's numerous civic improvements perhaps none is more vital than the water supply.

Philadelphia is one of the large cities in the United States which takes its water from rivers, namely, the Delaware and Schuylkill. These rivers are at present the only available adequate means of supply, and thorough purification of the water is necessary. To meet the ever-increasing demand many improvements have been undertaken, those made on the Queen Lane filter plant, the latest of Philadelphia's five filter plants, being most noteworthy.

FIG. 1. NEW PIPE LINE.

First let us consider the method of getting the raw water to this plant. Unpurified water is pumped to the filter from the Queen Lane Pumping Station, situated on the banks of the Schuylkill River, approximately two miles away. Four vertical triple expansion pumps supplied the power; the raw water being forced through two 48-inch pipes. These pumps are now being replaced by four turbo-centrifugal pumps, having a capacity of 160,000,000 gallons daily. The horse-power at the station will be practically doubled.

This increase in power and consequent increase in volume of water pumped to the filter plant each day has necessitated the construction of a new pipe line. This line will be of 60-inch steel pipe as shown in Figure 1. It is now almost completed. The course along which this line has been laid is noteworthy in its economic aspect. Instead of running it along Ridge Avenue and over Midvale Avenue to the filter plant it has been taken up School Lane and over Henry Street. The former route would have meant the tearing up of two streets which are in constant use and over which there is considerable daily traffic, while the route which has been chosen is over fields and little used thoroughfares, the distance being practically the same.

The Queen Lane filters in use at present were completed in 1911 by the Keystone State Construction Company, replacing the old reservoir, which consisted of a north and south basin with a total capacity of 350,000,000 gallons. The north basin was replaced by forty preliminary filters each 32x40 feet, and twenty-two sand filters 96x344.4 feet each. Under the slow sand filters is a 40,000,000-gallon filtered water basin. The south basin was left intact and used as a sedimentation basin, having a capacity of 175,000,000 gallons. In this basin the velocity of flow was reduced and the heavier suspended matters were taken to the bottom by gravity before the water was run to the preliminary filters.

Considering the annual report of the bureau of water the year after the completion of this and Philadelphia's four other filtration plants we can clearly see that the money was justifiably spent. "There averaged 14.1 deaths in each 100,000 population from typhoid fever, the lowest rate yet attained since the induction of filtration."

However since 1911 greater consumption demanded an increase in the water supply of the city, and as the advantage of the high elevation of the Queen Lane filters was such an asset it was decided to double their capacity as one of the first steps in increasing the supply. To do this made a change in the plan of filtration at the Queen Lane plant necessary.

Two distinct processes will now be used. (1) The preliminary filters will be reconstructed as a mechanical filtration plant. (2) The final or slow filters will be used as an individual plant.

Several additions are required in the converting of the preliminary filters, a coagulant being necessary. A head house is under construction for applying the alum and lime, while four new coagulation basins have been built. The raw water will be pumped from the river direct to this head house. Here the chemicals, alum and lime, will be added to that portion of the water to be used in the mechanical filters. The coagulation will take place in the basins. Mr. A. Hazen in his book, "Clean Water and How to Get It", describes coagulation as follows: "A chemical treatment resulting in drawing matters together into groups, thereby

FIG. 2. HEAD HOUSE UNDER CONSTRUCTION

FIG. 3. NEW COAGULATION BASIN.

making them more susceptible to removal by mechanical filtration, but without any significant chemical change in the water."

Figure 2 shows the head house about two-thirds complete. In the foreground can be seen the remains of the fountain which was formally used to aerate the water. The head house is arranged so that the alum, of which approximately fourteen tons will be used per day, can be most conveniently handled. Dry feeding machines, solution tanks, concrete storage bins, electric hoists and hand traveling cranes will be installed; in fact every mechanical means is used to reduce the actual manual labor to a minimum.

A 72-inch reinforced concrete pipe, 450 feet long, runs from the head house direct to the four new coagulation basins, the water being conducted by gravity. The basins are connected in parallel. The compactness of these basins is a notable engineering feat. No additional ground was available in the vicinity of the plant, therefore the banks of the old reservoir which still remain were leveled and the basins built on them. Figure 3 shows basin No. 1 which is now completed. It is 300x80 feet and has a cross-section of 950 square feet. There is a 9-inch concrete floor and reinforced concrete side walls. The three remaining basins are similar in construction and allow a sedimentation period of two hours.

The construction of the head house, reinforced concrete connecting pipe and four new sedimentation basins is being carried out by Edward Fay and Sons, Contractors and Builders, of Philadelphia, and when completed will be another added landmark to the numerous construction jobs undertaken by this well-known and long established firm.

The changes necessary in the old preliminary filters will be slight. The side walls will be made about two feet higher, thus increasing the capacity. A new strainer system has been designed and the old sand and gravel is being removed. The former is entirely replaced while the latter will be washed and restored and new filter sand placed upon it.

The present large sedimentation basin will be used in conjunction with the slow sand filters only, thus increasing the sedimentation period. These slow filters will handle 40,000,000 gallons daily.

Thus the old plant will, with the few changes noted above, be reconstructed to supply the increased demand. With 100,000,000 gallons daily from the mechanical filters and 40,000,000 gallons daily from the slow sand filters, the former capacity of 70,000,000 gallons daily will be doubled.

Atmospheric Gold

HARRY PRICE, '23

(Illustrations Courtesy of American Cyanamid Company)

NOT so long ago it was a frequent occurrence for promoters of get-rich-quick schemes to defraud people of hundreds of dollars by promoting enterprises for extracting gold from the earth or the sea. But I do not think any promoter ever thought of a scheme to extract gold from the atmosphere. If a landowner has a right to an expanding pyramid of air above him to the limits of the atmosphere, then for every square foot of his ground he owns $2,500 worth of atmospheric gold. This atmospheric gold is nitrogen. It is one of the most essential elements in the food of man and in the weapons of man. It plays a double role in human economy. It appears like Brahma in two aspects, Vishnu the Preserver and Siva the destroyer. We hope that the use of nitrogen in its maleficent aspect is a thing of the past, but the use of it in its beneficent is undoubtedly a thing of the future.

The dismal law of Malthus is true. The people are increasing at a rate beyond that of their food supply. Up to the present time an increase in population was taken care of by increasing the land under cultivation. In this manner the world has put under cultivation almost the maximum of food producing soil, so that now the problem is to increase the yield per acre and this can only be done by the use of fertilizers. Of the thirteen elements necessary for the growth of crops there is only danger of a shortage of three in the soil, nitrogen, phosphorus, and potassium, of which nitrogen is the most important. It is usually the first element to become deficient in the soil. Of every dollar that is spent for fertilizer fifty-two cents is paid for nitrogen, twenty-eight cents for phosphoric acid and twenty cents for potash.

Although the air surrounding the earth is four-fifths nitrogen, plants unfortunately cannot use it in the free gaseous state, but demand it chemically fixed with some other element or elements. For nearly a century chemists have sought ways of fixing atmospheric nitrogen by chemical means on a large scale, at low cost. The first commercially successful process, and the one that has attained the largest production is the Cyanamid process. There are two others in use, the arc process found in Norway and Sweden with the Cyanamid process, and the Haber, found only in Germany in addition to the Cyanamid process. Nine countries have the Cyanamid process, two the arc, and one the Haber process.

Air is a gaseous mixture which consists of four-fifths nitrogen and one-fifth oxygen. In the Cyanamid process the air is first liquefied by intense cooling under high pressure and pure nitrogen is boiled off, which is absorbed at white heat in a powdered mass of fused lime and coke. In the arc process air is blown through a flaming electric arc which burns the nitrogen and oxygen to nitric oxides, which are absorbed in water or in milk of lime to make nitric acid or nitrate of lime.

In the Haber process pure nitrogen is made by the liquefaction of air, the same as for the Cyanamid process. Pure hydrogen is produced by another method, and is combined with the pure nitrogen, under high pressure, at a red heat in the presence of platinum sponge or some similar catalyzer, forming gaseous ammonia.

VIEW OF OVEN ROOM

CARBIDE FURNACE

Cyanamid is the invention of two German chemists, Professor Dr. Adolph Frank and Dr. Nicodem Caro, and is the first process for fixing atmospheric nitrogen that was commercially successful. The first Cyanamid was made in 1898 on a laboratory scale. The first factory was erected in Italy in 1906 at Piano d'Orta. It produced five hundred tons the first year. In the following two or three years other factories were established in Germany, France, Norway, Austria, Switzerland, Hungary, Japan and Canada. The American Cyanamid Company was organized July 22, 1907, at Portland, and its first plant was completed in 1909 at Niagara Falls, Canada. This plant has a capacity of 12,000 tons per annum. Additions in 1913-14 brought the capacity to 64,000 tons. There was no Cyanamid or other air nitrogen industry in the United States before the war. In the year 1916 on the last available data the total production of Cyanamid in the world was 1,000,000 short tons.

The greatest cold and the greatest heat obtainable on a large scale are used in the manufacture of Cyanamid. The extreme coldness of liquid air is used to produce pure nitrogen gas. The extreme heat of the electric furnace is used to produce calcium carbide. The pure nitrogen absorbed by the powdered calcium carbide forms cyanamid.

Liquid air machines working under a pressure of five hundred pounds per square inch, reduce pure dry air to liquid air at 380° F. below zero. Air is four-fifths nitrogen and one-fifth oxygen. Upon allowing the liquid air to warm up slightly, pure nitrogen gas boils off, leaving the oxygen behind in the liquid. The nitrogen is pumped directly to the fixation ovens where it is to be combined with the powdered calcium carbide.

The powdered calcium carbide is produced in huge electric furnaces, each provided with three carbon electrodes six feet long and two feet square. A mixture of lime and coke is continuously shoveled up around the electrodes. The tremendous current of electricity passing through the mixture between the electrodes melts the lime to a liquid, which then combines with the coke in the interior of the furnace, forming calcium carbide. Every fifteen or twenty minutes the furnace is tapped from the side and the molten carbide is allowed to run into iron cars. As it issues from the furnace, it has a temperature of about 4000° F. and is so dazzling bright that it can only be looked at through colored glasses.

After the carbide has cooled for about a day in the cars, it is dumped, crushed and ground to a fine powder. It is then placed in huge perforated cylindrical steel cans and set in fixation ovens. The latter are heated from the center by electricity. When the temperature reaches about 2000° F. pure nitrogen from the liquid air plant is admitted. The carbide sucks up the nitrogen greedily, forming a new chemical compound, calcium cyanamid, $CaCN_2$.

When the absorption has stopped, the can is removed, allowed to cool, and is then dumped and the mass ground to powder. It is treated with a small quantity of water to remove the last traces of the carbide and to slake the free lime, and with a small amount of oil to prevent dusting. It is then known by the trade name "Cyanamid".

The tremendous amount of electrical heat energy required and the fact that the product which is to be used for fertilizer must be cheap make it necessary to have a large supply of cheap electricity available, and this can only be furnished through cheap water power. This is true not only of the Cyanamid process but it is also true of the other two fixation processes. The arc process requires five times as much electricity as the Cyanamid process to fix the same amount of nitrogen.

(*Continued on page 26*)

TOWNE TOPICS

LECTURES ON FRENCH UNIVERSITIES

Professor Jacques Cavalier, Rector of the University of Toulouse, France, is delivering a series of three lectures on French Universities and the Revival of Provincial Life in France, under the auspices of the Acting Provost and the Trustees of the University. The first lecture was given on Wednesday, March 1st. The remaining two will be delivered in Houston Hall at 6 P. M. on March 8th and March 15th. The lectures are given in French and are illustrated with lantern slides.

Prof. Cavalier is a noted educator and is a leading authority on metallurgical chemistry. He was appointed by the French Government as the first French Exchange Professor, in accordance with a plan organized by seven leading American Universities in connection with the French Government providing for the annual exchange with France of Professors of Engineering and Applied Science.

Prof. A. E. Kenelly, of Harvard, is the first American Professor under the terms of this arrangement. He is meeting with great success in his lectures before the French Universities and Schools.

Efforts are being made to have Prof. Cavalier address the students of the Towne Scientific School.

ENGINEERING ASSOCIATION

The last meeting of the Engineering Association was held in December, and due to Christmas vacation, midyears, and rushing season, no meetings have been held since. The next meeting is planned for the early part of March. Negotiations are under way to secure several men of prominence in the engineering world, among whom are Mr. Schwab and Mr. Vauclain.

WHITNEY SOCIETY

A meeting is being arranged for the early part of March, at which, if possible, there will be a lecture with moving pictures on the tapestry industry under direction of the Philadelphia Tapestry Mills.

It is planned to invite prominent alumni to future meetings, in order that members can come in contact with men who have made good in the profession.

HEXAGON

The Hexagon Senior Society elected the following men from the Class of 1922 to membership: J. M. Harris, Charles W. Foppert, A. W. Patterson, Edmund F. Burke, Frank F. Davis, William L. Boswell.

The Society will hold a banquet on March 9th. Henry E. Ford is in charge of the affair, and all alumni are urged to get in touch with him at 3909 Spruce Street before that date.

SIGMA TAU

At the Christmas meeting of Sigma Tau the following men were initiated: J. Lindsay, R. Fry, O. Shaeffer, J. M. Harris, H. Landenberger, A. Zimmerman, H. Wall, J. Clothier.

Since then E. Wheeler has been pledged as an active member and Prof. C. W. Fawcett as honorary member.

The annual banquet this year, contrary to usual custom, will not be held on Washington's Birthday, as this date conflicts with the Senior Week program. March 11th has been set as the day for the banquet, the place to be announced later.

All alumni are urged to get in communication with Charles W. Foppert, Chairman of the committee, and make arrangements to be present.

A. I. E. E. MEETING

The last meeting of the Pennsylvania Branch of the A. I. E. E. was held in Engineering Building, December 17th. Mr. Hutchinson, General Manager of the United Gas Improvement Company, gave a very interesting talk on his business experience and the things to be avoided by young men after graduation.

J. B. Clothier, '22, entertained by a few selections.

The next meeting will be held March 16th, and a very novel program is being arranged. This is going to be "Stunt Night" and to

make it a success the co-operation of every electrical engineer is needed. The entire program will consist of stunts put on by the various students. Anything will be considered a stunt, from a card trick to a wrestling match, and the man or men who put across the best act will receive a prize.

Don't forget the award that was offered at the last meeting for the man bringing the largest number of Freshmen and Sophomores.

SIGMA XI

At a recent meeting of the local chapter of the Sigma Xi Society, the following engineering students were elected into associate membership in the organization:

William E. Blecker, E. E. '22.
Russell W. Chew, C. E. '22.
John C. Hausman, M. E. '22.
Joseph A. Jenemann, Ch. E. '22.
Edwin L. Kessler, Ch. E. '22.
Carrol N. R. Kline, C. E. '22.
Isaac Lisansky, C. E. '22.
David D. Wells, Ch. E. '22.
George A. Knowles, Jr., M. E. '22.
Adolph O. Schaefer, Ch. E. '22.

PRIESTLEY CLUB

On Wednesday afternoon, December 14th, Prof. Robert H. Fernald, Director of the Mechanical Engineering Department, talked in the Harrison Laboratory Lecture Theatre on "How to Get a Job". The entire student body of the Chemistry Department having been excused from laboratory, was in attendance.

Prof. Fernald advised the students to draw broad specifications when looking for a job, even to accepting one not directly in their line. He warned against becoming a rolling-stone, but said not to remain at the same job more than three years if it offered no good opportunities.

Prof. Fernald also gave a few words of advice about marriage. He told the students that it was unwise to marry in a short while after graduation. He gave some pointers on picking a wife, the audience listening very attentively to the discussion on this most delicate subject.

Save up your pennies for the Engineers' Dance. It doesn't come until the end of the term, but when it does come—Oh My! !

TAU BETA PI

On the evening of January 6th, Tau Beta Pi held an initiation and banquet at the Normandie. At that time Dr. Walter T. Taggart was initiated into honorary membership in the organization. The following men were taken in:

Jesse B. Cooley, C. E. '22.
Edwin W. Denzler, C. E. '22.
James E. Warner, C. E. '22.
William Clever, C. E. '22.
Arthur W. Crisfield, M. E. '22.
John Hausman, M. E. '22.
Jacob B. Gallagher, E. E. '22.
Paul S. Darnell, E. E. '22.
Louis Fink, E. E. '22.
Robert Sergeson, Ch. E. '22.
David D. Wells, Ch. E. '22.
Joseph A. Jeneman, Ch. E. '22.
Ralph M. Cornman, Ch. E. '22.
Alexander H. Holcombe, 3rd, Ch. E. '21.

Tau Beta Pi is new on the Pennsylvania campus, although old nationally. The local chapter, Delta of Pennsylvania, was installed last May. The purpose of Tau Beta Pi is to mark in a fitting manner those who have conferred honor upon their Alma Mater by a high grade of scholarship as undergraduates, or by their attainments as alumni; and to foster a spirit of liberal culture in the Engineering Schools of America. It is planned to have a prominent engineer lecture to the students soon under the auspices of the organization.

HIGHWAY BRIDGE CONFERENCE

During the first week of the new term, a conference of leading highway bridge engineers was held at the University. The object of the meeting was to discuss present specifications for bridge design and to arrive at a standard set of specifications which might be nationally used. Two committees met in joint session for this discussion—one the Highway Bridge Committee of the A. S. C. E., and the other appointed by the association of state highway officials.

The general tendency at present is to design for heavier truck loads than before, on account of changing conditions. The result of the conference was very satisfactory.

A fuller report of the meeting by Professor Ketchum, Director of Civil Engineering, who was responsible for the conference, will be published in a later issue of the Journal.

MEN ABOUT TOWNE

A meeting of all the men interested in this year's Engineers' Show was held on February 28th. Plans were made for the annual banquet which is to be held this year at Bookbinder's on March 20th.

ALUMNI

THIRD ANNUAL DINNER OF THE UNIVERSITY OF PENNSYLVANIA CIVIL ENGINEERS IN NEW YORK CITY

The third annual dinner of the University of Pennsylvania civil engineers connected with the American Society of Civil Engineers was held during the annual meeting of the society on Thursday evening, January 19, 1922, at the Engineers' Club in New York City.

Those present were: Professors Ketchum, Berry and Pardoe of the civil engineering faculty; G. S. Webster, '75; W. L. Saunders, '76; G. T. Wagner, '81; C. E. Lindsay, '84; R. G. Develin, '90; W. M. White, '92; W. I. Lex, '96; W. W. Conard, '97; R. W. Tull, '97; J. P. J. Williams, '98; D. Gendell, '99; S. R. Jones, '99; C. Kendall, '99; C. W. Landis, '99; A. B. Hager, '00; G. L. Taylor, '00; D. D. Barlow, '01; W. H. Charlton, '02; J. Lowenstein, '02; R. B. Smith, '03; W. A. McIntyre, '04; A. W. Coombs, '05; H. A. Hilts, '05; P. G. Lang, '05; L. Perry, '06; C. S. Bilyen, '07; W. L. Cadwallader, '07; H. H. George, '07; W. G. Grove, '09; C. H. Schaefer, '09; C. L. Warwick, '09; M. A. Webster, '09; C. C. Campbell, '11; C. Haydock, '11; J. Wagner, '13, and C. Gilman and H. Gardner.

D. D. Barlow, '01, acted as chairman. Dr. W. L. Saunders, '76 Mining, Past President of the American Institute of Mining Engineers, was the guest of honor and gave a talk on the qualities necessary in an engineer who holds an executive position. Dr. Saunders, who is President of the Pennsylvania Club in New York City, also gave an outline of the proposed clubhouse in New York.

Following Dr. Saunders, short talks were given by G. S. Webster, '75, and S. T. Wagner, '81, and also some announcements were made by W. G. Grove, '09.

After the dinner those present attended the annual smoker of the American Society of Civil Engineers. These dinners have grown year by year, with increasing interest and attendance, and are now looked upon by Pennsylvania men as a definite part of the annual meeting of the civil engineers' society.

William G. Grove, '09.

Personal Notes

THOMAS MOORE, '98, is head of the department of mathematics and science in the Frankford High School. He also is chairman of the Philadelphia County Committee of the American Legion.

RALPH W. DEACON, '98, is with the United States Metals Refining Company at Elizabeth, N. J.

E. R. HALL, '02, is in the contracting and building business for himself, with offices at 24 S. Seventeenth Street, Philadelphia, Pa.

JACOB S. GOLDBAUM, '08, is sales manager of Fels and Company, manufacturers of Fels' Naptha soap products, of Philadelphia.

R. J. WAITE, '08, is in business at Boston, Mass.

GEORGE H. TABER, '11, of Tulsa, Okla., is a mechanical engineer with offices in the Sinclair Building in Tulsa.

E. D. Graffin, '13, is located at League Island with the Civil Engineering Staff.

William J. Haley, '14, has been promoted from the plant of the Standard Oil Company in Baton Rouge to a similar position in Charleston, S. C.

C. C. Meyer, '20, is a telephone engineer with the American Telegraph and Telephone Company, long lines engineering department, at New York City.

Clifford L. Fenton '16, of Hatboro, Pa., is with the Bell Telephone Company in their plant engineering department.

Henry C. Smith, '81, is division engineer of the Philadelphia and Reading Railroad with offices in the Reading Terminal, Philadelphia.

Howard Deacon, '82, of 3629 Locust Street, Philadelphia, is assistant engineer of the Bureau of Water. He is at present in charge of the modification of the Queen Lane filters

Albert K. Wilson, '16, is an industrial engineer with the Standard Oil Company of New Jersey. He is living in Elizabeth, N. J.

A. Haven Dale, '16, is a member of the firm of Morgan and Dale, architects, with offices at 426 Connell Building, Scranton, Pa.

Albert de Macedo, '16, is a representative of the Baldwin Locomotive Company in South America.

J. S. Bennett, 3d, '16, is in the construction department of the American Engineering Company in Philadelphia.

Frank D. Carvin, '16, is an instructor in mechanical engineering at the University.

THOMAS L. FOSTER, '16, is in charge of the Brazilian section in the foreign sales department of the Baldwin Locomotive Works.

A. MEMMILL REDDING, '16, is a salesman for the Leeds and Northrup Company, manufacturers of scientific instruments.

MURRAY C. BINFORD, '16, is an architect in Portland, Me.

RALPH E. HUGHES, '16, is with the Goodyear Tire and Rubber Company, engaged in development work.

JOHN F. G. GUNTHER, '16, is a member of the firm of Gunther and Cannon, architects, in Salt Lake City, Utah.

JAMIESON PARKER, '16, is an architect with offices in the United States Bank Building, Portland, Ore.

D. C. SPOONER, JR., '16, is with the General Electric Company with offices in the Witherspoon Building, Philadelphia, Pa.

MORRIS WISTAR WOOD, '21, is an instructor in physics at the Christian College, Canton, China.

Charles C. McCormick, '21, is with the Western Electric Company.

Charles E. Pennell, '21, is with the New York Telephone Company.

William H. Edwards, '21, is with the Western Electric Company.

S. Logan Kerr, '21, is with the William Cramp and Son Ship and Engine Building Company, of Philadelphia, in the C. P. Morris Department. His paper on the "Moody Ejector Turbine" has been awarded the junior prize for 1921 by the American Society of Mechanical Engineers.

ATMOSPHERIC GOLD

(*Continued from page 19*)

The Haber process takes only six-tenths as much power as the Cyanamid process, but the investment in plant equipment costs twice as much, and operation and labor cost is double that of the Cyanamid process.

The Cyanamid plant established at Niagara Falls in Canada on account of the relatively cheap water power available there produces about 64,000 tons of Cyanamid a year. About 30,000 annual continuous horse-power is required for this, hence one horse-power year makes about two tons of Cyanamid. It is the only nitrogen fixation plant operating on the Western Hemisphere. During the war the United States government undertook the construction of five plants but none of them were ever put in operation. The plant at Muscle Shoals about which so much is heard was built to operate on the Cyanamid process.

Our Campus

C. R. Dolmetsch, '25

ONE of the questions that has rankled the mind of every true Pennsylvanian is, "Why hasn't the University a bigger and more beautiful campus?" No doubt all sorts of mental answers and suggestions have been formed, and perhaps much deep thinking has been done, but so far all that has been accomplished is to have kept as beautiful as possible that patch of

green and trees in front of College Hall and the Library. There is natural beauty, too, along Hamilton Walk and throughout the Botanic Gardens, but the average visitor to the University never reaches those places unless they are specifically pointed out. What we want, then, is a more spacious and more beautiful campus—a campus park, as it were.

It has been suggested that permanent buildings be erected for the Sesqui-Centennial Exposition of 1926, and that these be later turned over to the University of Pennsylvania. Such a suggestion is indeed a worthy one, and deserves our deepest thought and consideration. Mr. Ralph Morgan, an alumnus, writing in the *Pennsylvania Gazette*, has even gone so far as to point out the fact that it was the duty of the City of Philadelphia to the University to promote a movement of this kind, because the University brings so much money into the city. In concordance with this plan, an appropriate step would be to make Thirty-fourth Street a beautiful, wide avenue, extending from the campus to Fairmount Park, where the exposition may be held. This would, of course, involve considerable

expense, but the eventual results would be recompense enough, because it would accrue for the University greater attention from the millions of people who would visit the exposition, and incidentally, greater favor and esteem from the rest of the city.

Princeton University is famous throughout the country for its splendid campus. It is generally conceded, too, that Cornell is a strong competitor for this honor. At Harvard, it is almost a necessity to ride a bicycle over the campus in order to reach the various buildings in time for classes, while Yale is far from occupying a place in the background. Columbia University, although located in so large a city as New York, has a campus worthy of more than passing attention. And so on down. Many and numerous examples come to one's mind, and we revert to the original query, "What about OUR campus?" Then follows the naturally logical question, "What can be done to beautify our campus, and to make it a thing of which we can be justly proud?" It is not the purpose of the present article to present specific plans and to give definite details to bring all this about, but rather to give in a general way a few suggestions that might some day be worth while.

So it is easy to see how we could improve the appearances of our campus, although frequent difficulties and obstacles would confront us. All kinds of suggestions can be offered, but until some actual step is taken, our question will still be with us, "Why can't we have a beautiful campus?" The possibilities that could be realized through the efforts of the alumni and trustees will remain a dream.

Nikola Tesla

THE name of Nikola Tesla will always be associated with the invention and earlier developments of the induction motor. In fact, at one time this type of apparatus was known almost exclusively as the "Tesla" motor.

Tesla devised this motor back near the beginnings of the electrical business, when practically everything was built by "cut and try" methods, and none of the accurate analytical processes of later days had been developed. It may be said broadly that Tesla knew two fundamental facts—first, that if a magnet were moved across a sheet of conducting metal, it would tend to drag this metal along; and, second, that the *effects* of such a moving magnet could be produced by suitably disposed polyphase currents acting on a *stationary* magnetic structure.

Perhaps others, at that time, also knew these two facts, but if so, apparently they knew them only as two isolated facts. Tesla considered them *in combination* and the result was the Tesla motor, or what is now known broadly as the "induction motor". These two facts, in combination, represent a fundamental conception, and all of the many millions of horsepower of induction motors in use today throughout the world are based upon these two fundamentals.

Naturally, Westinghouse, having fought singlehanded to advance the alternating current system, was supremely interested in the new type of motor. What if the new motor did require polyphase circuits, while all existing circuits were single phase? What if it did require lower frequency than any existing commercial circuits? These were merely details of the future universal alternating system. The important thing was to obtain an ideally simple type of alternating current motor, which Tesla's invention offered. Tesla furnished the fundamental idea.

He and his associates, working for Mr. Westinghouse, proved that thoroughly operative induction motors could be built, provided suitable frequencies and phases were available. What matter if they did not produce an operative commercial system at the time? What matter if it needed the powerful analytical engineers of later date to bring the system to a truly practicable stage—men with intimate constructive knowledge of magnetic circuits—men on intimate terms with reactive coefficients and other magnetic attributes totally unknown to Tesla and his co-workers? In time the motor was made commercial, and it has been a tremendous factor in revolutionizing the electrical industry.

Probably no one electrical device has had more high-power analytical and mathematical ability expended upon it than the induction motor. The practical result has been one of the simplest and most effective types of power machinery in use today. Thus Tesla's fundamental ideas and Westinghouse's foresight have led to an enormous advance in the world's development.

Westinghouse

WESTINGHOUSE ELECTRIC

THE FRANKFORD "L"

(*Continued from page 7*)

ment. That inference is correct. Furthermore, considering the Frankford "L", as a whole, and comparing it in every way with the existing Market Street line, one can not but be impressed not only by its obvious superiority, but by the painstaking thoroughness and consideration for the convenience of the public on the part of City Transit's engineers which made that superiority possible.

A much mooted question, the basic reason in fact, why the lease for the operation of the "L" has as yet not been approved, is the following: Is the probable earning power of the Frankford Elevated such as to make it a paying proposition?

Mr. Mitten, President of the Philadelphia Rapid Transit Company, makes the following statement concerning this much discussed subject:

"The operation of the Frankford 'L' by the company for the city is made difficult because of the misinformation originally fed to the public as to the probable earning power of this extension. Continued repetition of the statement that the operation of this line would be particularly profitable to P. R. T. has made a distinct impression on the public mind.

"The passengers to be carried on the Frankford 'L' will be largely drawn from the paralleling surface lines. There will therefore be, after withdrawing all possible surface cars, a large resultant net loss to surface lines following this diversion of traffic.

"With increased cost of operation as now represented in higher wages, fuel and cost of material, it is not thought that the Frankford 'L' can earn much, if anything, in excess of its operating costs. P. R. T. considers it imperative that the public's present misapprehension of the earning capacity of the Frankford and Bustleton lines be corrected."

In answer to the same question, Mr. J. R. Conroy, Traffic Engineer, Department of City Transit, comments as follows:

"The operation of the Frankford line, it is true, will divert traffic from the company's surface lines, which diversions will cause a net decrease in the earnings of those lines of about $900,000 during the first year of Frankford operation. The first year's diversion would be the maximum, after which it would gradually disappear. In West Philadelphia, following the opening of the Market Street Elevated, the surface lines regained their normal traffic in a comparative short period. This loss to the adjacent surface lines, the engineers are in substantial agreement, will be the only decrease in P. R. T. net income in connection with its leases of the Frankford line.

"City Transit estimates indicate that the earnings on the company's lines, at present rates of fare, will be sufficient to absorb the $900,000 reduction in net income caused by diversions to the Frankford 'L', and to allow an ample return to P. R. T. stockholders besides.

"There is no justification, therefore, for the company's present attitude toward the Frankford 'L' lease. There is no strength to its argument that a higher fare will be required to support the line. It is plain that the company is endeavoring to profit by its advantageous position, and by the peculiar need at this time for its co-operation, to secure concessions which, if granted, would not only be detrimental to the city's interest in connection with the lines in question, but would seriously cripple the city in later negotiations for the operation of the other city-built lines, which must be established at the earliest possible date."

That Mayor Moore has unmistakable views of his own on this Gordian situation may easily be gleaned from the following:

"There is no question upon the part of the city as to the advisability of a unified railway system throughout Philadelphia. The Philadelphia Rapid Transit Company, however, has control of all existing lines except the Frankford Elevated Railway and its subsidiary lines, which have been the subject of such long-time negotiations. The city favors a unified system with thorough routing so that the best and broadest service can be obtained for the car riders, but the point has been reached where it seems vital, if any service is to be secured looking to a unified system, that the issue be forced by municipal operation of the plant it owns and controls: this whether an agreement can be ultimately reached with the Philadelphia Rapid Transit Company or not."

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Bon Voyage

DEAN JOHN FRAZER of the Towne Scientific School and Professor of Chemistry, has been chosen as Exchange Professor to France for the coming academic year by the Committee on Exchange with France of Professors of Engineering and Applied Science, representing Harvard, Columbia, Cornell, Massachusetts Institute of Technology, Johns Hopkins and the University of Pennsylvania. The Board of Trustees has granted Doctor Frazer a leave of absence from June 1922 to September, 1923.

The movement for the annual exchange with France had its origin as the result of a letter written before the death of the late President of the Massachusetts Institute of Technology, who communicated with the presidents of a number of Eastern universities suggesting the great desirability of such an arrangement with the French government and calling attention to the fact that whereas there has been for some time a regular exchange of professors between individual universities of France and America in other fields than engineering, there has never been as yet any such exchange in engineering and applied science, these subjects being taught in France under special professors not included in existing exchanges with America.

Dean Frazer goes not merely as representative of the University of Pennsylvania but as representing all of the seven participating American universities. In the course of his duties in lecturing in French before the various universities and scientific societies of France, Dean Frazer has an unusually favorable opportunity of studying at close range French education, especially as applied to science.

The University may well feel honored at having a professor from its body picked from the above mentioned Universities and sent to France. The Towne Scientific School should feel doubly proud that one of its own graduates and professors has been selected to fill so important a position. We have Doctor Frazer to thank for many things that have happened about the Engineering School, among which was the reopening of the smoking room in this building .

Doctor Frazer has done much to make this Journal a possibility. He gave encouragement and official support to this publication and is whole-heartedly interested in its success. The Towne Scientific Journal takes this opportunity to wish Doctor Frazer the best of success in his teaching in France and we hope and feel assured that the Frenchmen will appreciate his sincere associations as we have. Here's to you, Doctor Frazer!

Alumni

TO THE members of the Class of 1922 it may seem odd that the Alumni Association should be so anxious to immediately enroll them as members, but, as a matter of fact, the younger men mean as much to the life of the Association as any of the older men could possibly mean. It is to the younger men that the Association must look for the development which is to occur in future years. The graduates of today will be the leaders of tomorrow, and the destinies of Pennsylvania lie in the hands of those men who will, as active alumni, control the policy of the University.

Every Engineer owes it to himself and to Pennsylvania to join the Alumni.

Vale!

THE board that has completed its task of resurrecting the JOURNAL has departed. With the old board go the good wishes of the incoming board for luck in their life work. If their efforts in the future are as earnest and sincere as they have been for the JOURNAL, success will be theirs. When they started work at the beginning of the year everything was against them. They were forced to solicit ads with no sample of the magazine; they had to write most of the material themselves; the outside help, from the students, the alumni, and the faculty, which was later so generously given, was at first entirely lacking. The entire work of rehabilitating the JOURNAL was entirely in the hands of the retiring board.

To all of the members of the board the greatest credit is due, but to the members of the Managing Board must be given the greatest share of the thanks and appreciation of the school. John Cornell's untiring work as Business Manager made possible the publication of the paper. "Eddie" Burke originated the policy and carried out the plans which gave us a paper worthy of Towne. "Charlie" Foppert, as Circulation Manager, secured the interest of the students in the magazine.

To these men, and to the entire board, we owe much and we wish them all the success in the world.

THE end of the school year has come again. It is a time of much bustle and confusion and doing of things that should have been done long before. Theses which deserve months are finished in weeks and a corresponding hashing over of courses is quite general. In the midst of this inevitable result of human nature it is a bit hard to stop for a while and carefully consider just what it's all about. But of all times this is the time to do that very thing. Another year has passed and our destinies have been that much more fulfilled. A light begins to glimmer in the darkness of the future and more fully we realize to what ends we have applied ourselves. And now for the point of this somewhat rambling discourse. We must now decide—now and no later—that which we really think to be worth while. A man may have any good thing that he wants provided only he wants it badly enough. So drag out those dusty ideals, you engineers. Select the best of them and follow it doggedly through the paths of sacrifice and progress.

The Mallet Articulated Locomotive

HARRY PRICE, '23

(*By courtesy Baldwin Locomotive*)

ALTHOUGH there is a great amount of discussion concerning the relative efficiencies of the steam and of the electric locomotives the steam locomotive has not become a thing of the past at present. Not so long ago the birthday of Abraham Lincoln occurred. He is spoken of as the preserver of his nation, but without the locomotive the United States at present would be divided into at least two nations. With the slow transportation and communication offered by the stage coach this nation would have fallen in fragments long ago. The great empire founded by England was founded by means of vessels but the great empire of the United States was the result of locomotive transportation.

The appearance of the present locomotive does not by any chance class it as a simple device, but it is almost an axiom in all construction that the simplest devices are the best, and this applies to the locomotive. If the limiting conditions such as the stability of the road-bed, the gauge of the rails, the tractive effort necessary, the speed necessary and the curves encountered were capable of a simple solution there would be no triple articulated locomotives which are the largest and the most complex locomotives ever constructed. A triple articulated locomotive is nothing but a set of wheels driven by steam by means of a piston connected so as to give the highest efficiency.

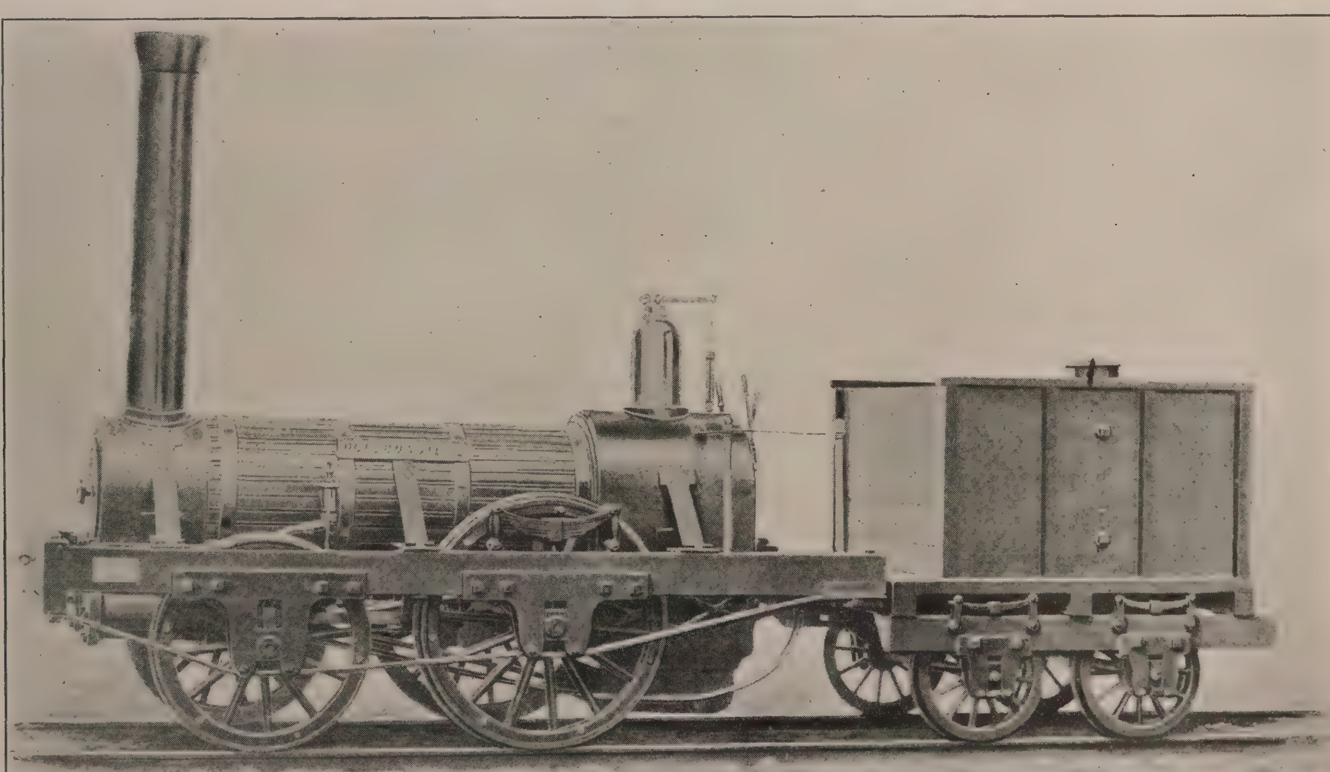
To work a railroad economically as small a number of trains should be used to do the work as possible. This means the locomotives in the greater number of cases should be very powerful. However, there are a great many factors influencing the increase of power of locomotives. If it merely was accomplished by increasing the size of the locomotive and incidentally its weight this could be allowed for by making the rails of heavier and more durable material and the stability of the foundation increased. The increase in power of a locomotive means a corresponding increase in the size

TRIPLE ARTICULATED LOCOMOTIVE, ERIE R. R. THE LARGEST BALDWIN LOCOMOTIVE THUS FAR BUILT.

of the boiler. When the boilers were as small as they were on old Ironsides the boiler could be conveniently placed between the wheels, but when the boiler increased to the present size of about seven feet in diameter while the standard gauge remained constant at four feet eight and one-half inches, the height of the boiler above the rail had to be increased to ten feet from an initial value of four feet. There is another constant factor influencing the height of the boiler and that is the force of gravity. Any further increase in the present height of locomotive boilers would tend to put the locomotive in a state of unstable equilibrium. This means that unless the standard gauge is widened the increase of power of a locomotive in respect to a cross section perpendicular transversely to the rails is no longer possible. The only way this could be done is increasing the gauge but this would be a tremendous undertaking and the width of the gauge promises to remain constant. The next logical way to increase the power of locomotives would be to turn to the cross-section perpendicular and parallel to the rails, in other words to an increase in length. Under ordinary conditions an increase in length means an increase in power, but also an increase in rigidity, which would be a severe defect in any road with a normal number of curves. It would cause excessive wear on the rails and on the flanges of the locomotive's tires. The thing that puzzled locomotive engineers for a long time was increase in power without a decrease in flexibility or efficiency. The first locomotive constructed in the United States, "Old Ironsides". This locomotive was of rigid construction and had two pairs of wheels only, one of which did the driving. To increase the flexibility of this type an introduction of a four-wheeled truck in place of the front pair of wheels was made. This rigid front type of locomotive was enlarged to the present so-called Santa Fe type of locomotive which consists of five pairs of driving wheels with a two-wheeled truck in front and in back. Notwithstanding they are close connected their rigid wheel base is nineteen feet, nine inches. During the time of this type a great many attempts were made to increase the flexibility of the locomotives by building two locomotives together usually back to back, a very grotesque contrivance, but one which was actually used in a number of cases. Another attempt made in this direction by an American builder to have one boiler and one set of driving wheels which were swiveled and a rear truck which carried the water tank and fuel on the rear extension of the locomotive frames.

But the one who actually converted the articulated

(*Continued on page 16*)



Old Ironsides—First Baldwin Locomotive.

Senior Trip of 1922

C. G. McAnally, M. E., '22

THE Tenth Annual Inspection Trip of the Senior Class in Mechanical Engineering started officially at 8.10 P.M., Thursday, March 29th, when the train pulled out of Broad Street Station. Strange to say, everyone was on time—twenty-three students and Professor Fernald. The evening was taken up by card playing, reading, talking and some back-fence harmony. The instruments brought along were a banjo, a mandolin, a piccolo and two mouth organs. Some good music and some questionable singing were obtained, however we all had a good time and we got in our bunks about twelve or later. Two of the boys had their moustaches clipped off during the night, and we were ready to settle down to sleep again.

The first plant visited was the Jones and Laughlin Steel Company—the south side works on the outskirts of Pittsburgh—a bad section. We met Mr. Kernohan, the General Manager, who was a student of Mr. Fernald at one time. After the introduction we were given pass buttons and several guides to take us through the plant. The plant is situated on the banks of the Monongahela River and is very crowded. Every square foot and even cubic foot is utilized. Rails, ingots, scrap cars, etc., were piled everywhere. There was scarcely room to walk.

We went back to the Hotel at noon for lunch, and at 1.15 left for the National Tube Plant at McKeesport.

The plant is a mile and a quarter long and 600 feet wide. It is well laid out, with plenty of room for building, blast furnaces and offices. One of the rolling mill buildings has the largest floor area under one roof—for a one-story building. It is one-third of a mile long and has a floor area of 23 acres.

Friday morning we awoke about 7.15, very tired, and looked out on rain. We also noticed a deep layer of cinders over everything in the room because we had left the window open. We hurried down to the basement cafeteria, had some breakfast, then went to the station to take the eight o'clock train for Irwin, Pa.

On the trip out we missed Boswell and Stephanov. We thought they were probably still sleeping, and we would have two less in the class to graduate in June. However, they showed up at the mine about one half hour after we did, having taxied out from Pittsburgh at a cost of thirteen dollars. Professor Fernald allowed them to remain for the rest of the trip.

After going through the mine "a real honest to-goodness lunch" was served and we left for the station to take a train back to Pittsburgh and felt that a very profitable day had been spent, especially for those who has seen their first mine.

April first broke cloudy as usual, but cold, and some snow was observed along the tracks on the way into Cleveland. Arrived O. K. and took a trolley to Hotel Statler—a very nice hotel in a nice city. After having been assigned rooms and breakfasting in the hotel cafeteria, we left at 8.45 for the plant of W. S. Tyler Co.

This plant was shut down on account of taking inventory, so that we could not see the machinery going. However, we saw enough of the plant and with the able explanation of Mr. Steffen, the superintendent who has been with the company 49 years, we were able to understand how it all worked.

We then took the car back to the hotel for lunch and a few minutes' rest. The sun was shining for a change, which was very welcome. At 2 P.M. we left the hotel for Division Station of the Cleveland Water Works.

We received our first view of the muddy Mississippi on our way into St. Louis. Arrived there on Monday, April third, a warm, clear day. After checking our luggage and getting a little something to eat, we left for the plant of the Union Electric Light and Power Company. This plant shows very plainly the rapid strides in engineering as shown by the up-to-date equipment and modern methods of power plant operation.

We left early for the hotel, took a nap, ate, then a crowd of us walked up town and spent the evening at a skating rink. Came back to the hotel feeling that we had had a good workout.

Tuesday, April 4th, was clear and warm for a change. Men from the Heine Boiler Company called for us at the hotel and took us to the plant. This plant was another that took an interest in us and considered it worth while wasting time on us. A mimeographed sheet showing the program of events had been distributed and called for a lecture and motion picture of the manufacture of their product. The lecture was given by Mr. Fish, and both this and the movies were very interesting, because when we went through the shop we recognized what we had seen and knew what was being done.

After shaking hands all around, taking some snapshots and receiving the booklet, "Boiler Logic," we were driven back to the hotel, where we ate and prepared for the afternoon trip.

At 1.30 we left for the Annhauser Busch plant. We first signed the registration books, then all the boys

stepped up to the bar and had a drink of near beer. Those who didn't touch this stuff were given a glass of a new drink—Grape Bouquet—just out. Tastes like grape juice with a little more kick and surely is good.

Finally we went through the Busch Seltzer Diesel Engine Works. A government test was going on and no visitors were allowed, but at the time the test was stopped so we were allowed to go through. We were not told much, and had to make good use of our eyes. We saw many engines in the process of construction and two large engines being worked upon, either of which may have been the test engine.

We then headed for the hotel and then for Union Station and climbed aboard a sleeper. During the night several of the boys were blackened up to represent minstrels, I suppose, and on Wednesday, we looked out at Keokuk, Iowa, in the rain, the place of which we've read and heard so much. We checked our luggage at the station and after breakfasting at the Hotel Iowa, left for the great power house of Keokuk. The dam is worthy of note because of its length, seeming to stretch as far as the eye can see. The turbine room also deserves mention, because of the 15 very large units stretching out into the distance. From this point on, nearly all the places visited are noted for their size, which has not been the case so far on the trip.

After walking all through the plant from dam to roof and then to intakes, we left for the Hotel Iowa, where we all gathered round the festive board and made merry at lunch—all had a good time.

At 1.55 we left for Chicago, following the banks of the Mississippi all the way to Burlington then cutting across Illinois to Chicago. The country was very noticeably flat or rolling. After sleeping part of the afternoon, the crowd resorted to the banjo and mandolin toward dusk and passed the time till 9.30 when we reached the Windy City. A taxi was the quickest means of reaching the hotel and also inexpensive.

Chicago is surely a live city. Reminds one of New York only not as large, however it seems just as peppy. After a little walk around the streets and some crullers and coffee we returned to our rooms and lost no time in getting some valuable sleep.

The plant of the International Harvester Company was visited next. It is one of those noted for its magnitude, seeming to stretch as far as the eye can see, the whole works covering a vast amount of ground. After walking fast for three hours, we were told that we had covered about 20 per cent of the total distance—and we had not loafed any on the way.

At five we left the plant and returned to the hotel to dress and wash and get ready for the Alumni Dinner in the evening. Very good spirit prevailed at this dinner between Alumni and Seniors. Mr. Brunker handled

SENIOR MECHANICAL ENGINEERS

the meeting and gave us some good dope. Mr. Brown, a pitcher in his undergrad days, spoke some good words of advice. The main topic of the evening was that the graduate's character, or rather his activities while in school and the interest taken in outside activities, count more than that which he gets out of books. Professor Fernald told the Alumni some of the present doings on the campus and also gave his views on the subject of the evening. John Carter spoke a few words for the Seniors. After the banquet some of the boys went to shows and others to bed.

We then left for Gary on the 12.03 train. As we travelled toward the plant of the Illinois Steel Company we were impressed by its size, there seeming to be no end to the plant. We were told that it was three miles long and a mile wide. It is an imposing place. One cannot comprehend the magnitude of such a plant. After walking all afternoon, we were told that we had covered about 12 per cent of the works.

Monday was clear and cool when we arrived in Detroit. Took a taxi to save time, and arrrived at Hotel Statler to have rooms assigned. At 8:30 men from the Connor's Creek plant of the Detroit Edison Company called for us with machines.

The plant is very up to date and very efficiently operated.

Upon arrival at the Ford plant, we were given booklets describing the working of a Ford, and one guide for the whole group. This plant is very wonderful, and scientific management is carried to the nth degree.

Tuesday was cloudy and a rainy day. In the morning we left for the Parke and Davis plant. This plant took some interest in us, and divided us into small groups with some good guides. Among them Mr. Buell and Mr. Fritz, the latter now assistant superintendent and only six years out of college. After seeing the plant we were taken to the lunch room and given a very good lunch on the company. After a few speeches

(*Continued on page 20*)

The Cold, Cruel World

EDITOR'S NOTE.—*The author of this article, inspired by a modesty not too often found in recent college graduates, has asked us to withhold his name. We don't like to do this, because the article's so doggone good that we think the writer deserves a little free advertising on the strength of it. But just the same—anonymous or otherwise—we'd like to have some more things of this sort from our Alumni. We can look with reverence upon, and perhaps absorb some benefit from, the grandfatherly preachments of the Class of '42, but it is from our recent graduates that we learn best of the conditions which we ourselves must soon confront.*

LAST June, the writer stood up with some score or more embryo civil engineers in the Metropolitan Opera House, listened to some excellent speeches and advice, lifted a hired mortar board from his head, shifted the bearing of the tassel, replaced it and stepped boldly out into the cold, cruel world.

This was the final touch to the product of a machine. It is the purpose of this article to describe a few of the experiences of the product that other bewildered products may gather courage from them or regard them as a warning, as the reader may see fit.

It is unfortunate that one must eat, particularly in times of business depression. Your writer let it be known that his services were available for immediate use. There was no rush of applicants to be his employer. Industry and development were dead; so the writer was assured, and he was in a fair way to enter the broader fields of engineering (so described by Professor Fernald, in tabloid Power Plants for so called civil engineers), the field of engineering chorus girls, or insurance sales, auto hearse driving, or the maxima and minima of elevator operation.

Much to the writer's surprise he finally got a job in highway work, liked it and is still at it. Bread and butter is forgotten in the joy of dreaming dreams and working them true. Perhaps you will be interested in one man's experience in adapting college training to the work-a-day world. It is felt that some one who is coming into the engineering world, "knowing not whence, willy nilly blowing", may derive some amusement, if not downright help, from a sketchy history of one trodding the path, a lap or so ahead.

I went to the Capitol and talked to an official. (I suspect that some one on the faculty did some talking too, but a careful perusal of the marks obtained on my scholastic record furnish no clue to his identity.) I like to talk. I hope I talk more than words. To talk ideas one must have ideas. If the ideas are second-hand, they are doubly hard to defend. One's own ideas are crystallized in their defense.

Well, it so happened that there was an opportunity for a worker and a talker, there usually is. In this case, the natives of a certain locality in a State that shall be nameless, were dissatisfied with the highway department. Bonds had been floated for roads and roads had not been built. There was much technical discussion of a technical body by technical ignoramuses. It is peculiar that nearly everyone you meet considers himself a competent engineer. People will call in and respect a doctor or a lawyer; but an engineer? Goodness no!—To get back to my story, which seems to be developing by the cut and try method, someone was needed to produce work in an atmosphere of hostility. I was elected.

I carefully searched all the indices of hundreds of dollars' worth of textbooks for hostility and a formula for its solution. Alas, I was thrown on my own resources. Pitiful wasn't it? With a "we who are about to die, salute thee" attitude, I went into the sticks.

In a short time I had to choose a route for a highway. The best route obliterated a hedge of which a farmer was very proud. When acquainted with the facts he wanted to argue with a pitchfork. I'm slightly lame and can't run, so it was a contest of pitchfork and I'm afraid specious logic. It's a peculiar fact, gentlemen, that a trifling amount of culture re-enforced with the courage of desperation may be a match for material forces. In this case it was. Armed with Philosophy I (Summer School), Economics I (Same Source), and Engineering Contracts, including I'm afraid, a little contorted torts, I won the day.

In a second instance a farmer objected to a route. He armed himself with a shot gun and an unknown quantity, but high quality, of moonshine. Engineering economics made no impression on alcohol, transits were no match for buckshot, so I lay in a ditch while lead whistled overhead and waited for the repeated stresses in his brain to cause fatigue. His elastic limit grew less and less, the alcohol under the law of gravitation descended to his hands and feet and as he lay helpless, we finished the survey. I knew physical law better than he did. I won.

Now, these two experiences prove two things, at least I feel that they do.

Firstly—Where there is no recorded experience

available for solution of a problem, the man with the best cultural education wins. As a member of the Faculty in English so aptly expressed it—"The best expert is the fellow who knows most about all the other things."

Secondly—Where there is recorded experience, the man who has it at his finger tips or knows where to get it wins. *This is practical training.*

I cannot help but wonder, if the fellows who are following "the broader phases of engineering" are doing so because of their inability to convince a prospective employer of his two-sided development, if he had one. I cannot help but wonder if he has not blamed everything and everyone but himself for a failure to get a start. The difficulties encountered by the graduated student are well known. Have you ever looked at the other side?

It really is dangerous for such a babe as myself to attempt, seriously, to offer advice. However, with things regarded as having little value, I am a Marxian socialist. I share them. Advice is, by accepted definition, very cheap. I will lay myself open to a charge of sophistry and give you advice for what it may be worth.

The college professor is faced with a problem with two very serious sides. He must do his best to make a graduate self supporting and at the same time prepare a man to rise in his profession. Neither of these things can be accomplished through the using of defective material; students without ambition or incapable of understanding. Blockheads can be crammed and pass a course creditably. Weak sisters without ambition can be carried along with the force of their co-workers. Men who are unfitted do graduate, but do they survive? Gentlemen, do you know, that even in political organizations, the chap who doesn't or can't produce does not survive?

Your professors lay things before you that would tempt the person unable to avail himself of them and you take "enough to get by". If the world does not receive you with open arms, I can hear you cry "Four years of drudgery for this!" Drudgery? If it's drudgery to you, get out. You can bring nothing but discredit on yourself and your fellows.

Have you ever played poker? Successfully? I never have. I've won at times, but to win is to lose. My gains were not earnings. Easy come, easy go. You never get something for nothing.

I slighted some of my courses in college. They have evaporated from my memory. I wasn't interested in them. But, thanks to the faculty, I was forced to do enough work in them to know that my work did not lie along that side of engineering. I put some work into them. I am well repaid.

Some of the fellows who were not placed, I remember as being inarticulate. Given the best training, both practical and cultural, the man who cannot express himself cannot market his services. All other things being equal, the fellow who can talk on his feet, wins.

Gentlemen, I started these few words in the spirit of being entertaining. If I have bored you with the "sophistry", I beg your pardon. If I have stimulated one serious convolution of your brains, I have written off one mite of my indebtedness to Towne Sci. Hail Pennsylvania!

The Franklin Field Stadium

R. H. Laird, Jr., '23

AT LAST there will be enough seats for every one at the football games. The construction of the new stadium, seating fifty thousand people, was started May first and will be ready for the football season in the fall.

The old stands are to be completely torn down and taken away, but the present playing field and running track, however, are to remain unchanged. It was felt that the advantages of the size and shape of the present track were so great that it was best not to alter it. So the two-twenty yard straightaway and the quarter mile with its single turn will stay.

The new structure will be built of steel and concrete throughout, and will be faced with brickwork to match the outside of Weightman Hall. The outer wall of the stands will be over the curb on South Street and on Marston Street. On the east side it will be adjacent to the Pennsylvania Railroad property line. The wall will be carried on attractive brick arches along the curb line. Thus the sidewalk will be undisturbed, being arcaded in a manner similar to that on the east side of Fifteenth Street south of Market Street.

Under the stands and extending entirely around from the west end of the North Stand to the west end of the South Stand in the shape of a huge "U" will be a spacious concourse, which will aid materially in filling and emptying the stands.

Each section of the stands will have a separate entrance leading direct from the pavement on the South Street side and accessible on the Marston Street side by means of ramps, or sloping passageways. The East Stand will be provided for in a similar manner by ramps leading from the stands into the concourse and there will be portals opening from the concourse under this Stand to an eighteen-foot pavement next to the railroad. This pavement will be on a level with South

Street at one end and by means of steps will be brought to the level of Marston Street at the other end.

A cross-section of a stand will show that the rows of seats are arranged like those in the upper gallery of a theatre, that is, the space from back to back of the rows becomes less the higher the seats are placed. So an observer in the twentieth row in the new stands will be closer to the field than he would have been in the old stands, even without considering the fact that the first row in the new stands will be nearer to the field than at present. The East Stand will be curved so that the outside corners where it meets the North and South Stands will be only ten feet farther from the center of the field than they are now. It may be mentioned in passing that the top row of seats will be fifty feet above the field.

There will be team rooms at the west end of both the North and South Stands. Also under the stands will be a rifle range, rowing rooms, squash courts, and a room large enough for high jump, pole vault, broad jump and shot put.

Careful attention has been paid to making so huge a structure not only attractive and pleasing to the eye, but also to harmonize with the general architectural effect attained by all the newer buildings on the campus.

The University will have every reason to be proud of her new stadium. It is a product of the skill of some of her own graduates, notably Major W. H. Gravell, '06, who designed all the engineering part of the structure, and Mr. P. H. Wilson, '01, who is in charge of the construction work.

H K N Convention

ON APRIL 7th and 8th, Eta Kappa Nu Electrical Engineering Fraternity held its eighteenth annual convention here in Philadelphia, the members of Pennsylvania's chapter, Lambda, acting as hosts to the thirty delegates who represented chapters from technical schools all over the United States. The attendance was 100 per cent. Every active chapter, including the newly established ones at the University of California and Oregon Agriculture College, was represented by one or more men.

Because of the great amount of business connected with the convention, four sessions were held—three in Room 313 of the Engineering Building and one at the Hotel Normandie on Friday evening, April 7th. The convention was formally opened on Friday morning with an address of welcome by J. B. Clothier, '22, president of Lambda Chapter. Between sessions time was found to make several campus excursions in order to give the visitors, most of whom had never before been in Philadelphia, an idea of our university.

All the men were most favorably impressed and were not loath to make known their opinions. They were surprised at the small size of our campus but were awed by the hugeness of the University as a whole. (Any undergraduate can testify that the 12:30 rush from classes on Friday is an awe-inspiring sight.) The lacrosse game between Oxford-Cambridge and Pennsylvania, the Dartmouth baseball game, a sightseeing

(*Continued on page 19*)

.·. TOWNE TOPICS .·.

On Friday, April 28th, the members of the upper classes of the Civil and Electrical Engineering departments attended a lecture by Mr. Williams of the Chicago, Milwaukee and St. Paul Railroad. The subject was "Problems in Railway Electrification," and the talk was well illustrated by slides and motion pictures.

Mr. William G. Grove, '09, lectured to the members of the student chapter of the A. S. C. E. on Friday, May 5th. He described the reconstruction of a railway bridge over the Thames at New London, Conn. Mr. Grove is chief engineer for the American Bridge Company at New York, and designed the features of the reconstruction. The lecture was illustrated by slides and was extremely interesting.

Mr. Grove also told of plans which are being developed for the purchase of a clubhouse for the use of Pennsylvania alumni in New York.

SENIOR CIVIL BANQUET

The Senior Civils led by O. W. Levin held their first get together at Cafe Louis on May 4th. This meeting proved to be a great success.

At the luncheon a wealth of information was given out including the dog, which went to Sam Greenwald. Class honors were announced, the following being successful:

Beau Brummell—A. W. Levin.
Most Popular Fellow—G. Haines.
Most Popular C. E. Prof.—Prof Pardoe.

All the elections were closely contested. Plans were laid for a class organization for the Senior Civils.

Following the luncheon, the class went to the Shubert, where they were entertained by local talent.

Every member of the class proved to be an integral part in providing a delightful evening.

PRIESTLEY CLUB NEWS

On the evening of April 8, 1922, the Priestley Chemical Society presented its annual show, "Who's Zoo In Chemistry," before a capacity house in Room 314 of the Engineering Building. The minstrel-farce was the product of the pen of J. William Lipp, '23 Ch., who also played in the role of an end-man. The plot of the minstrel was based on the meetings and the initiation of the "I Brakab Urette" colored fraternity; the first act was the regular business meeting, at which nominations were made and candidates elected; the second act was the initiation of the two newly elected candidates. In the first act, the rapid-fire line of jokes between the end-men, Robert L. Patterson, '23 Ch., and Harold C. Gift, '22 Ch.E., coupled with the original songs, kept the entire audience in a high state of humor. The second act continued well the good work of the preceding one, especially through the clever efforts of J. William Lipp, '23 Ch., and Adolph O. Schaefer, '22 Ch.E.

The musical numbers were well rendered and very entertaining. Most of the songs consisted of original stanzas fitted to familiar tunes. The dancing by the chorus was a feature of the songs, and commendation is due to A. L. Robinson, who coached the dancing, for the success of these numbers. Praise is also due, too, to F. Q. Thorp and H. P. Wall, for their excellent specialty banjo number.

Appreciation is also felt for the splendid service rendered by the members of the orchestra, under the leadership of Harold E. Hattersley, '22 Ch.E., and to the various committees which worked so energetically in erecting the stage, and in arranging the electrical apparatus.

After the show, the room was cleared of chairs, and a dance conducted, music being furnished by the Theta Chi Fraternity Orchestra.

About a week before Easter vacation began, at a special meeting of the Priestley Chemical Society, a resolution for the adoption of a new badge was presented and duly passed. The new pin is the outcome of a design submitted by A. L. Omohundro, '25 Ch., and is a golden Erlenmeyer flask with the legend, "Priestly Club" in black letters. Most of the active members, and many of the alumni members in the faculty have already subscribed, and a large number were distributed at the last smoker, which was held in the lecture theatre of the Harrison laboratory on the evening of April 28, 1922. At the latter affair, Mr. Lansburgh, of the Wharton school, spoke on "Scientific Management."

At a previous similar affair, held March 22, 1922, Mr. Carner of the Lee Rubber and Tire Co., Conshohocken, Pa., gave a very interesting and instructive talk on "Rubber in Industry." Refreshments and smokes were in abundance, making the whole both a profitable and enjoyable evening.

TAU BETA PI

AT THE recent initiations and dinner of Tau Beta Pi, Dr. Harold Pender was received into honorary membership. The following men from the class of 1923 were initiated:

Julien E. Bodle, Ch., Joseph E. Brown, M. E., Thomas E. Cushing, M. E., John J. Geoghegan, Ch. E., Harry R. Halloran, C. E., Joseph W. Lipp, Ch., Frederick G. Outcalt, C. E., Albert C. Rayner, C. E., Nicol H. Smith, Ch. Rollin A. Clark, '21, was also initiated.

On the evening of May 2nd the chapter held a dance at the Wynnefield Country Club.

GEORGE S. WEBSTER ADDRESSES CIVIL ENGINEERING SOCIETY

The April meeting of the Civil Engineering Society opened with a short business meeting followed by a talk by George S. Webster.

Mr. Webster, who is a Pennsylvania graduate, is at present consulting engineer of the Delaware bridge commission. He is also president of the A. S. T. M., former president of the A. S. C. E., and at one time chief of the Bureau of Surveys of Philadelphia.

After a few words of encouragement to the men, Mr. Webster gave a most instructive and interesting talk covering the plans, details of construction, and economic advantages of the bridge. Many slides were shown, illustrating the talk.

Some interesting facts, as brought out by Mr. Webster were, "This Delaware bridge when completed will be the longest suspension bridge ever built, the three spans totaling 3,189 feet." "22,000 miles of wire will be used in the cables." "The completed bridge will accommodate 7,000 vehicles daily from New Jersey alone," etc.

At the close of the talk refreshments were served.

On the afternoon of April 12th, Mr. C. E. Drayer, Secretary of the American Engineering Association, delivered an interesting talk to the senior and junior classes in Civil Engineering, on the "Utilization of Engineering Knowledge." Mr. Drayer's close association with influential engineers and the fact that he has traveled extensively made the talk of great importance to the graduating class. In conclusion, a very interesting poem was read, copies of which can be obtained by applying to Prof. Ketchum.

Forecasting Heating Loads

How Normal Outdoor Temperatures May Be Used to Determine Most Economical Equipment

William B. Campbell, '22

(*Reprinted by courtesy Heating & Ventilating Magazine*)

THE science of heating has developed from the endeavor to eliminate or minimize the unfavorable effect of the weather on our indoor activities, and the intelligent consideration of heating problems involves the study of the laws which it follows, in spite of its proverbial variability. While it is impossible to predict daily variations, Government records extending back for long periods show that for a particular location there is for each day in the year a "normal" outdoor temperature, above and below which the observed temperatures range, and which remains the same if averaged over a period of years, regardless of whether it represents a group of recent observations or some of the earliest in the history of the Department. The curved lines in the charts accompanying this article represent the annual range for these normals for a number of American cities, the ordinates indicating the normal temperatures, and the abscissae dates. Each space between the heavy vertical lines stands for the month indicated, the middle of the month being shown by a light line, so that particular dates are easily estimated.

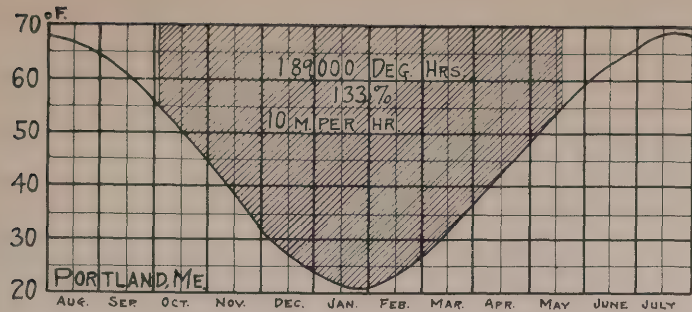
It will be noticed that these curves assume the general form of the sine curve: $y = a + b \sin x$. The date in January where the lowest temperature is reached corresponds to the angle 270°, whose sine is —1; the peak in July corresponds to 90°, whose sine is +1; the midpoints in April and October represent 0° and 180°, where the sine is 0. The constants, a and b, have different values for each particular curve, a representing the median normal, and b the maximum divergence (plus or minus) from this median.

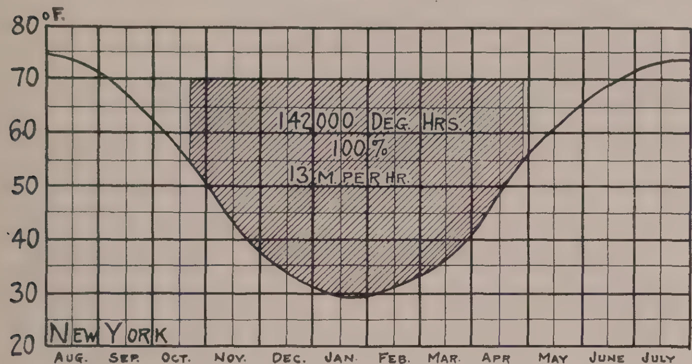
The heating of buildings involves maintaining the necessary temperature difference between the temperature prevailing outside and the desired inside temperature, generally 70° F. The accumulated heat from the sun's rays, human animal heat, moving machinery, etc., tends to maintain this temperature inside the building, protected from outside winds, when the temperature begins to fall, but when it reaches a normal of 55° F. outside, artificial heat becomes necessary. This fixes the normal length of the heating season, which differs widely, being from December 20th to February 20th in New Orleans and from October 3rd to May 3rd in Minneapolis. The normal heating load is a function of the distance 70° is above the curve for the central portion of this period.

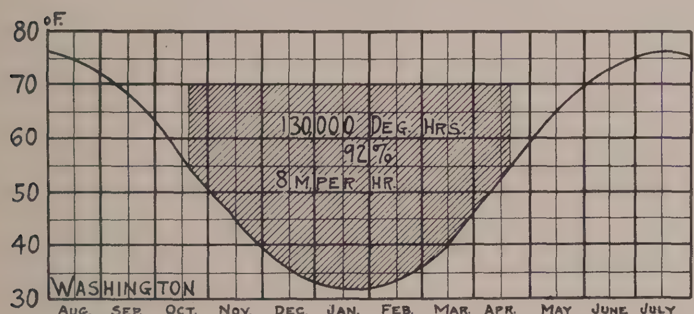
Prudence will dictate, in designing a heating equipment, that it be physically capable of keeping the building warm on the "coldest day on record," even though this may mean a temporary overload and waste of fuel, but it does not pay to install extra radiators and steam equipment just to provide for operating economically at an emergency which occurs once in two or three years. The question of whether the building is to be occupied by the owners or by "finicky" tenants who demand full heat every day in the year, serves to fix the "factor of safety," that is, the allowable amount the capacity of the heating system may fall short of providing 70° in exceptionally severe weather. The minimum atmospheric temperatures can always be ascertained from the local weather bureaus.

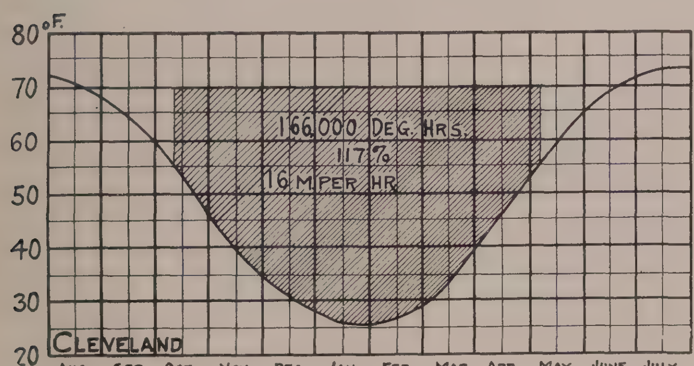
Load Which Plant Must Handle at Most Economical Rate

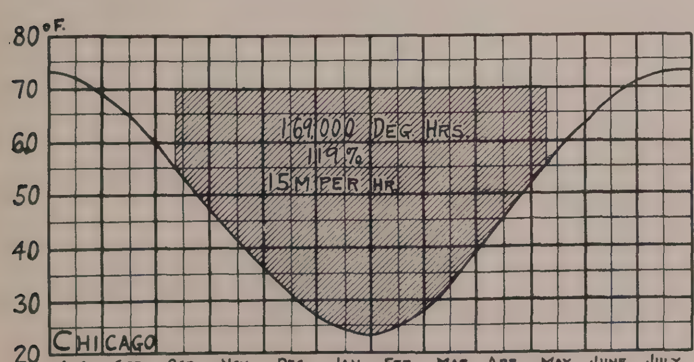
The temperature difference in the trough of the curve is however the criterion for normal operation of the plant, and the equipment must handle that load at the most economical rate, in dollars per day. The heat to be supplied is a function of the temperature difference times the "per-degree" losses, figured for the different exposed areas of the buildings, according to their construction and position. The amount of heating surface to be installed is that which will give out the necessary heat from a circulating medium at the most economical temperature. A comparison of the heating load with the anticipated light and power load makes it possible to determine, on an economy basis, whether it will pay to generate power in the building, using the bulk of the exhaust to heat the building in the water, and the remainder for heating boiler feed-water. The same consideration will determine the capacity of the engines and boilers to be installed, it being recognized that an equipment that will carry the normal load at maximum economy will operate somewhat over or under load and still maintain a good degree of economy.

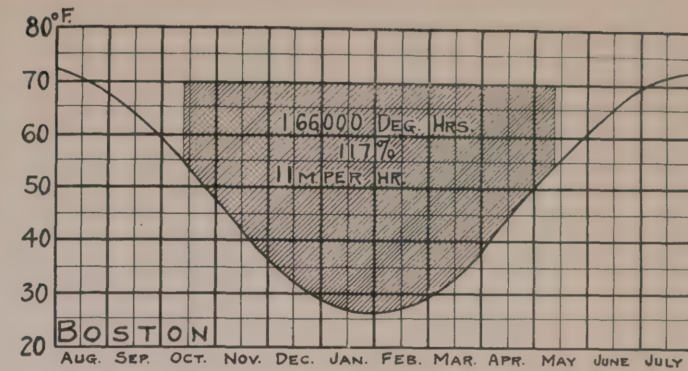

189000 DEG. HRS.
133%
10 M. PER HR.
PORTLAND, ME.

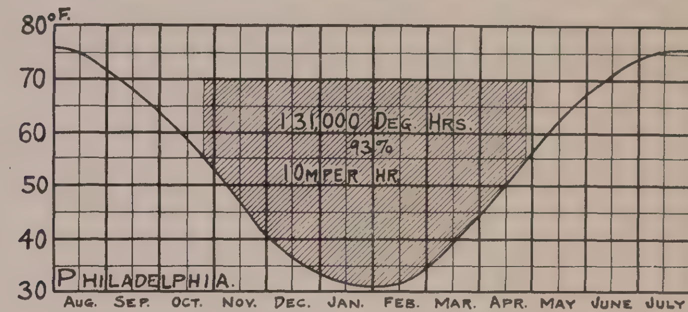

142000 DEG. HRS.
100%
13 M. PER HR.
NEW YORK

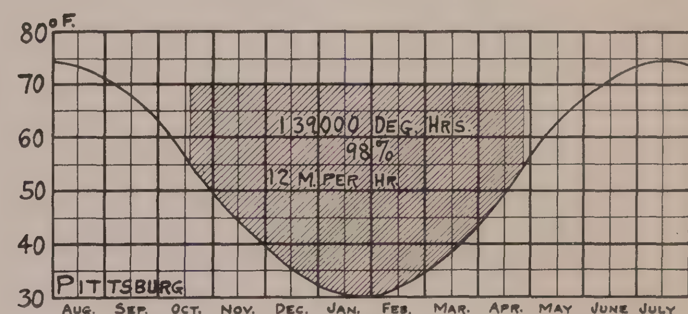

130000 DEG. HRS.
92%
8 M. PER HR.
WASHINGTON

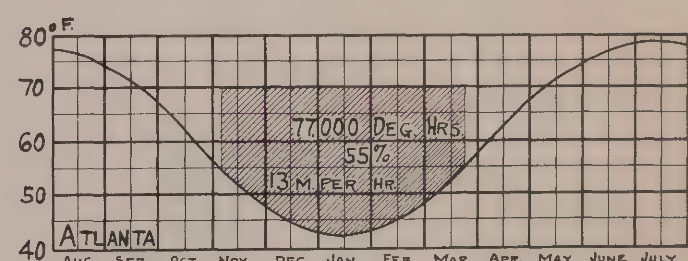

166000 DEG. HRS.
117%
16 M. PER HR.
CLEVELAND

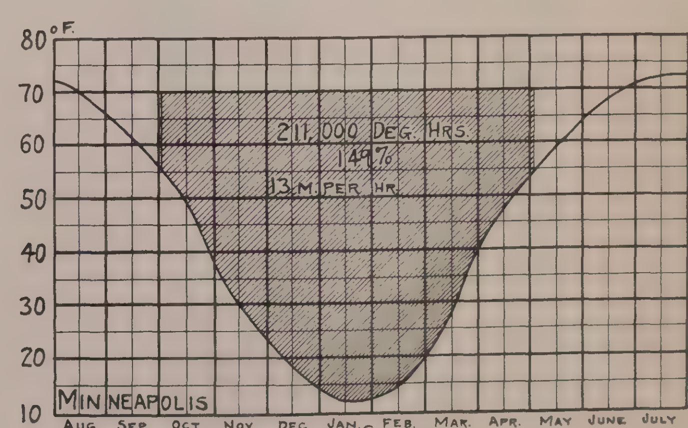

169000 DEG. HRS.
119%
15 M. PER HR.
CHICAGO


166000 DEG. HRS.
117%
11 M. PER HR.
BOSTON


131000 DEG. HRS.
93%
10 M. PER HR.
PHILADELPHIA.


139000 DEG. HRS.
98%
12 M. PER HR.
PITTSBURG


77000 DEG. HRS.
55%
13 M. PER HR.
ATLANTA

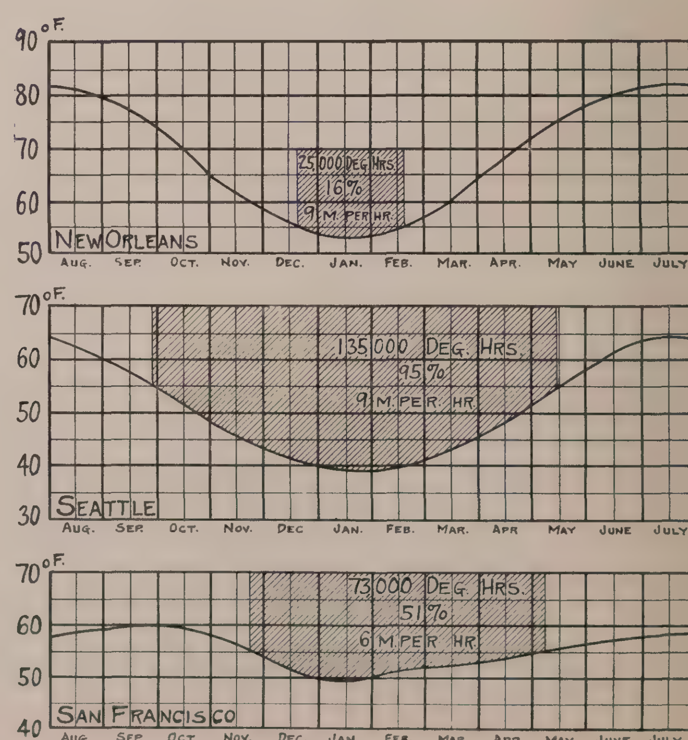

211000 DEG. HRS.
149%
13 M. PER HR.
MINNEAPOLIS

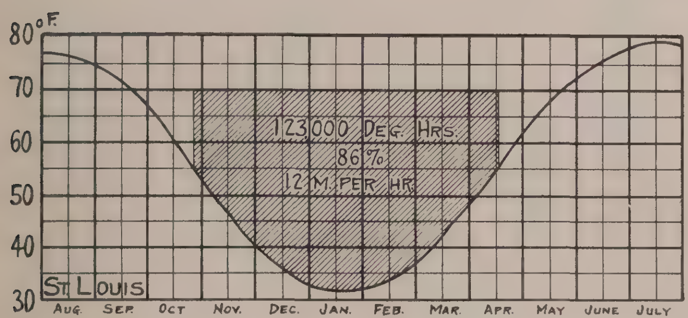
Heating Load a Matter of Duration, as Well as of Intensity

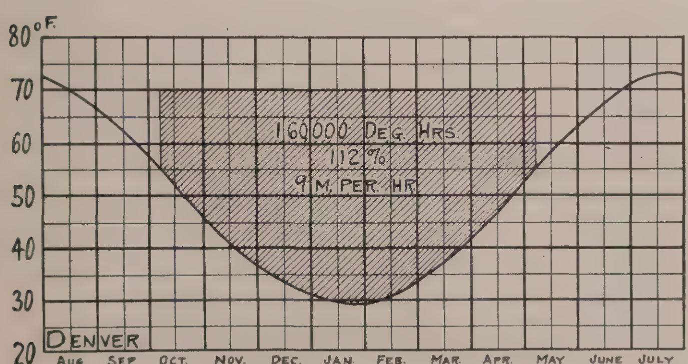
The heating load is not only a matter of intensity, but of duration, and the total heat to be supplied during the year is represented by the shaded areas above the curves. These are expressed in "degree-hours", each of these units representing the maintenance, for an hour, throughout the building, of a temperature difference of one degree between it and the outside air. 1,000 deg.-hrs. represents the maintenance of 40° temperature difference for 25 hours, or 20° difference for 50 hours. The total heat to be supplied during the year will be the temperature loss from the building "per degree per hour," multiplied by the number of degree-hours, and the fuel consumption will be proportional thereto.

Practical Use of "Normal" Temperature Data

Probably the most satisfactory results from such data are of an empirical nature. That is, it is possible to compare a projected operation with an existing building of a similar construction in another city. This eliminates all uncertainty as to transmission coefficients, and puts the problem purely on the basis of a comparison of the relative amount of heat consumed by the two environments. The mid-season normal heating load can be compared, the length of heating season, and even the total load, which will be a gage of the total coal required and other heating equipment charges to be included in the estimated rentals. For purposes of comparison, these degree-hour loads have been reduced to a percentage basis, with New York as a standard, the relative loads of the cities represented being as follows:







(*Continued on page 22*)

ARTICULATED LOCOMOTIVE

(*Continued from page 5*)

locomotive from a vision to an achievement was Anatole Mallet, a French Engineer. The distinguishing feature of this type of locomotive can be briefly described as follows, viz., two sets of driving wheels, each having an independent set of frames, cylinders, pistons, cross-heads, connecting rods and valve gear, yet all under one boiler with a single firebox. The rear set of driving wheels is held in frames secured to the boiler and to the high pressure cylinders, which are also fastened to the boiler. The forward set of driving wheels is held in frames which have a limited transverse motion about a pivot joining them to the rear frames. This pivot is located on the center line of the engine at a point about midway between the two sets of driving wheels. The forward set of driving wheels connected to the low pressure cylinders which are not fastened to the body, but hung to the forward section of the frames with which they swing transversely. The waist of the boiler is supported by sliding bearings which rest in turn on the forward section of frames and spring stops are provided to prevent undue transverse motion.

The steam is conveyed through rigid pipes to the high pressure cylinders. After exerting its energy the steam is exhausted into a flexible receiving pipe through which it passes to the low pressure cylinders. The final exhaust is effected through a second flexible pipe connecting the low pressure cylinders with the exhaust nozzle in the smokebox. Hence this type of locomotive comprises two complete engines with but one boiler, and possesses the advantages of compounding without entailing detrimental complications, as the forward engine is practically a duplicate of the rear one, except that its cylinders and pistons are of sufficiently greater size to compensate for the reduced steam pressure. The forward engine is designed to swing transversely in order to divide what would otherwise be an abnormally long rigid wheel base into two short rigid wheel bases, thus providing for the negotiation of curves. To further facilitate curving, or to support overhanging parts and steady the locomotive, leading and trailing pony trucks or else carrying wheels are somethimes used.

Two great advantages of this type of locomotive are the elimination of slipping and conduction of high pressure steam through rigid pipes. In the early types of articulated locomotives the high pressure steam was conducted through flexible pipes, through which it was impossible to prevent leakage. This often caused the view of the engineer to be obscured by condensed steam, a dangerous disadvantage. If the engines of an articulated locomotive exert different tractive forces—as they often do—there would be a great tendency to slippage. This cannot occur in a Mallet type readily, since the two cylinders depend on each other for distribution of steam. If the high pressure engine should slip, its exhaust would fill the receiving pipe faster than the low pressure engine could relieve it, and the resulting back pressure on the high pressure piston would prevent

(*Continued on page 23*)

ALUMNI

David C. Spooner, Jr., '16, is in the publication department of the General Electric Company. He lives at 106 S. Thirty-eighth Street, Philadelphia.

Howard Stoertz, '16, of 4741 Rosehill Street, Philadelphia, is a resident chemist with the Electric Storage Battery Company.

C. Ghriskey Watson, '16, is connected with the firm of Charles M. Ghriskey's Sons, wholesale hardware dealers. He lives at 3936 Walnut Street, Philadelphia.

Samuel T. Wagner, '81, is chief engineer of the Philadelphia and Reading Railway, Reading Terminal, Philadelphia. He is living in Germantown on Schoolhouse Lane.

Robert R. Hall, '94, is a distributor for the Cadillac Motor Car Company, being located at 1376 Broadway, Denver, Colo. He lives at 919 East Eighth Avenue, Denver.

J. S. Frankenfield, '16, is connected with the Cooper's Creek Chemical Company of West Conshohocken, Pa. He lives at 236 N. Fifty-third Street, Philadelphia.

J. H. Gibson, '16, of Merion Pa., is distributing manager of the Whitlock Coil Pipe Company.

George M. Dillingham, '16, is cost engineer with the Turner Construction Company of Philadelphia.

Roy W. Juckett, '16, of Hot Springs, N. D., is manager and owner of the Hot Springs Motor Company, distributors of Ford cars and Fordson tractors, public garage and service station.

H K N CONVENTION

(*Continued from page 10*)

tour of Philadelphia, and a banquet at the Normandie completed the convention program.

The Lambda delegates who were emphatic in their "ayes" and "second the motions" were E. B. Wilford, '22, and O. W. Manz, '23. J. D. Lawrence, '22, was appointed toastmaster of the banquet held Saturday evening.

The guest of honor at the banquet was Dr. Pender, who is an honorary member of Eta Kappa Nu. During his address to the delegates he said:

"We all know that the convention has been a success in regard to the transaction of the fraternity's business, but we, of Pennsylvania, hope it has been successful in another way. You men have come from all over the country. We have never seen you before and you have never seen us before. We know that you have been sizing us up and looking over our engineering school and university, and we hope you will like us as well as we like you. If you men leave here with a good impression of us and a friendly feeling towards Pennsylvania, we shall feel that this has been indeed a successful convention."

The hearty applause which followed Dr. Pender's talk was a fitting close to the 1922 Convention of Eta Kappa Nu.

SENIOR TRIP OF 1922

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we returned to the girls' rest room to get our coats and hats. We found the girls dancing and began to cut in. Then we sang some songs and left, after giving a yell to make a good impression. We were told we did. This helps.

After returning to the hotel and waiting around awhile five Cadillacs called for us, manned by Bill Butler who took charge of the trip to the Cadillac plant. A lecture was given on the quality of the car, the layout of the plant and the system employed. After they had taken a picture of us in the rain we started on our trip through the plant. The quality of the car was evident all the way through, and in some cases the accuracy to which they carried their measurements seemed ridiculous. The car and the methods of manufacture contrast sharply with those in the Ford plant.

We were brought back to the hotel in the Cadillacs and dressed for our banquet to Professor Fernald. A very good meal was served, also some music by local talent. After the meal all the boys were called on to say a few words, and nearly everyone thanked Professor Fernald and told now much he enjoyed the trip and appreciated Professor Fernald's attitude toward us. Finally the Professor was called on. He said a few words to us, and thanked us for the bouquets which had been thrown.

The next day we arrived at Niagara Falls—raining again. Checked our baggage, ate and walked to the Niagara Falls Power Company. A guide was furnished until we were rescued by Mr. Harper, Vice-President of the Company, who told us all about the place.

Mr. Harper then gave us a talk, amd impressed us very much, after which we returned to the town and ate again. At 12.45 most of us met at a certain place and walked across the bridge to the Canadian side, then along opposite the fall as far as the Canadian Horseshoe Falls. Some pictures were taken, although it was cloudy. The Fall is surely an imposing sight. It made a fitting close for the two weeks' trip.

We then boarded the car for the gorge trip going down the river, past the rapids and the whirlpool to the Queenstown Chippewa Plant.

After this the trip was officially closed and we completed the gorge trip going down the river, then crossing to the American side and following the river back to Niagara. When we arrvied in Buffalo that evening, the whole class separated, the boys going in all directions and feeling that that trip had been a decided success, both from the mechanical and the real engineering standpoint, the latter being that indefinable something that we call life.

All the way along the trip, we were told that business seemed to be picking up and that the companies were increasing their working forces. We all agreed that a two weeks' trip is more essential in the M. E. course than any other course that is given.